DATA PROCESSING

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Accounting machine plus paper tape punch

How a small organization, employing 80 people, has now the best of both worlds: rapid, efficient handling of its mass of clerical work and, by passing the punched paper tape on to a computer centre, statistics all-important to its future

THE existing accounting staff, 18 in number, was overloaded. More people could not be employed because of a shortage of accommodation. Further, the management considered it would be unfair to employ additional staff who could not be retained if seaborne trade declined. And the fact remained that insurance claims were not being dealt with as rapidly as they should be.

Faced with these problems, and the others that inevitably arise with manual clerical systems, Thomas R. Miller & Son, who with a staff of 80 administer the marine insurance work for the United Kingdom Mutual Steam Ship Assurance Association, Ltd., set about finding a solution. They installed a National Class 31 accounting machine coupled to an automatic paper tape punch. All the documents required for the insurance claims were redesigned and grouped together so that they could be prepared simultaneously on the accounting machine. With this machine, data entered on the keyboard, in addition to being printed on the documents, are punched automatically into 5-channel paper tape. The arrangement is that this punched tape is then sent to the National-Elliott computer service centre,* where the data are analysed on a 405 computer.

In effect, Thomas R. Miller & Son are achieving the best of both worlds by using a single accounting machine in their own office to speed the preparation of routine paperwork and

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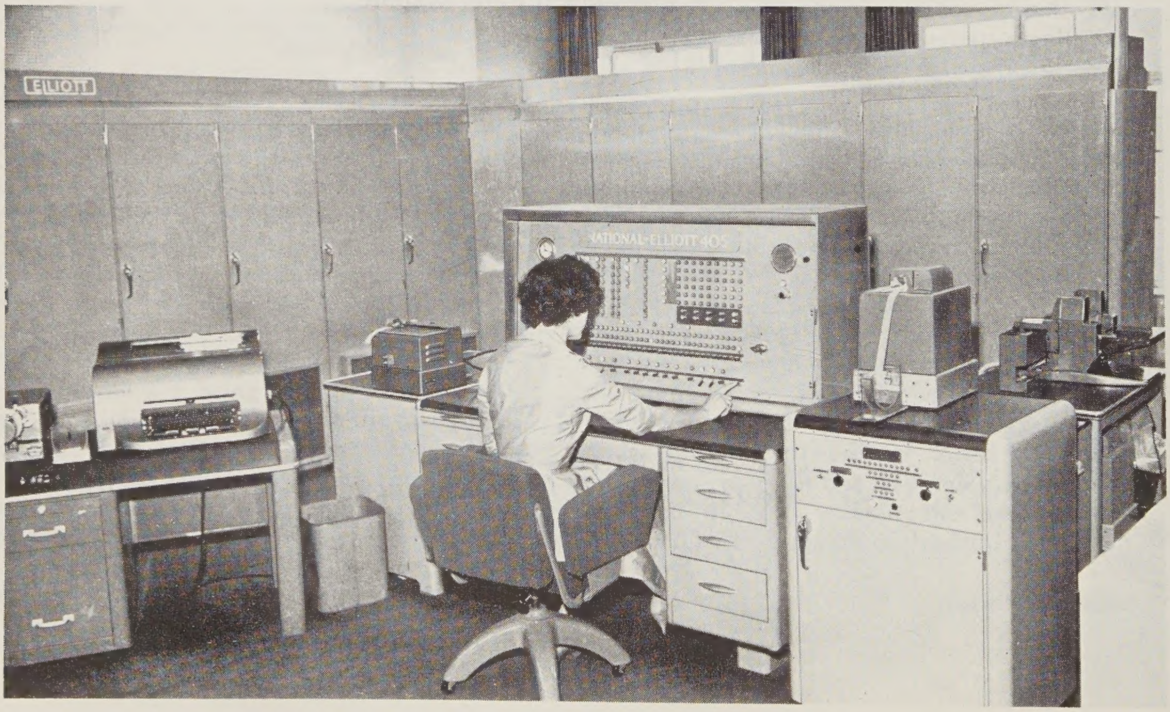
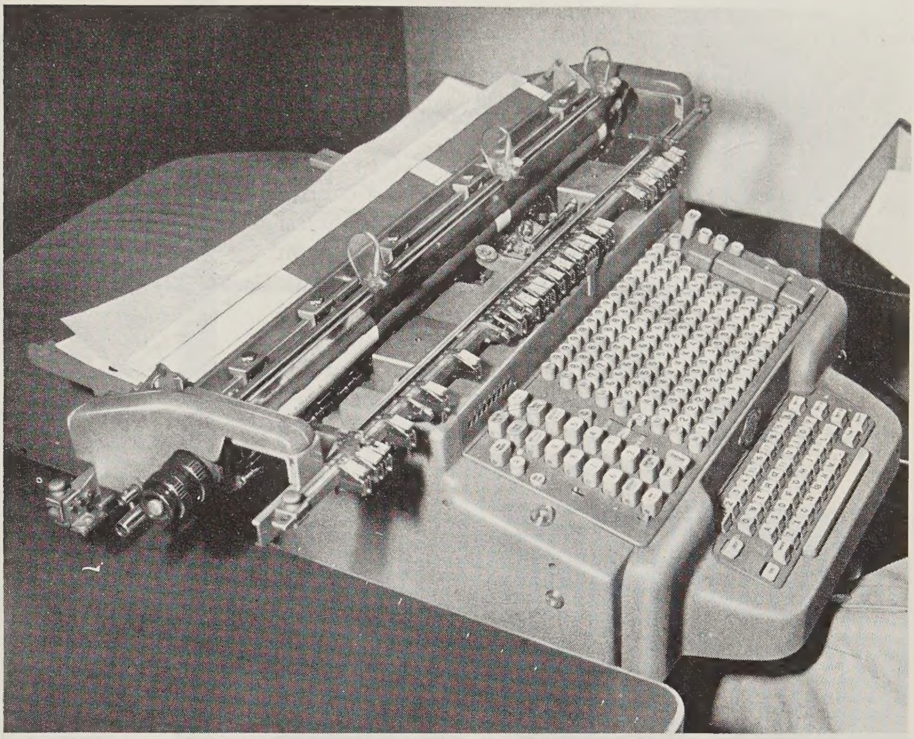
*The National-Elliott computer service centre in Great Britain is at 206 Marylebone Road, London, N.W.1.

This National-Elliott 405 computer produces marine insurance statistics from claims data recorded on punched tape



(Right) As insurance claim documents are printed by the accounting machine the information is punched simultaneously into 5-channel paper tape

(Below) Removable bar fitted with adjustable stops that controls the tabulation of the accounting machine carriage



hiring time on an electronic computer to produce comprehensive statistics from data selected and transcribed automatically on to paper tape as a by-product of the first operation.

Although the accounting machine has only been in use for a little over a year, many tangible savings have been made already.

Every day, documents for up to 300 claims are prepared on the accounting machine. Previously, this work would have taken one clerk a week to complete. Since the introduction of the machine, four of the original staff of 18 engaged on this work have left, as a result of normal wastage, and it has not been necessary to replace them. Claims are dealt with more promptly and, in addition, statistics are available that were previously unobtainable. Not least, the machine has eliminated much of the onerous work of checking columns of figures and tracking down clerical errors.

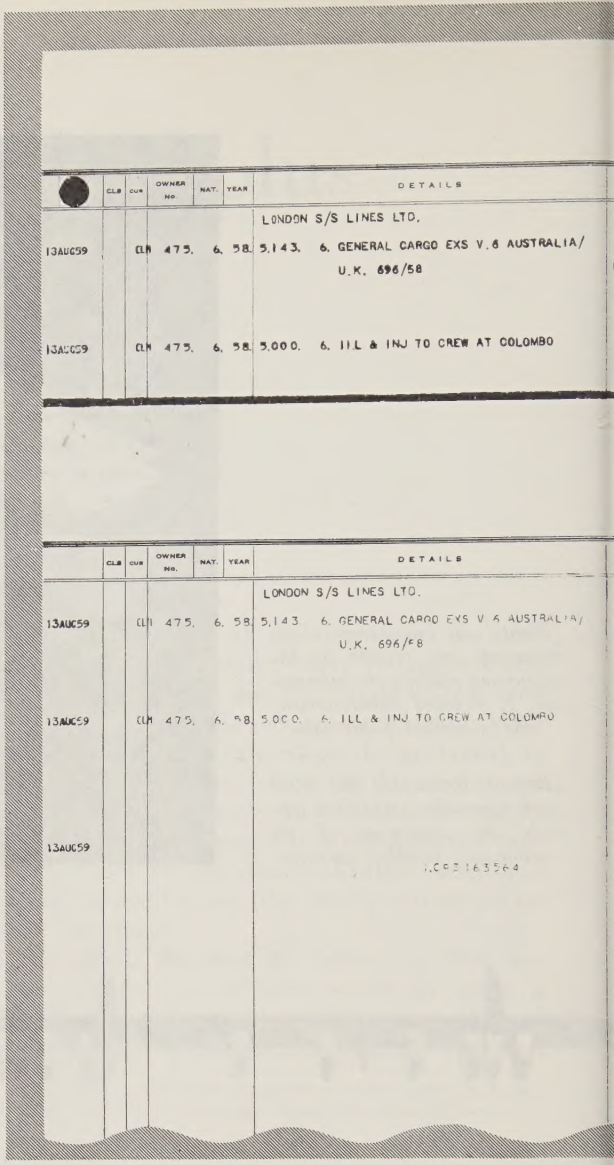
The National Class 31 accounting machine used for this work has two keyboards: an electric typewriter keyboard and an amount keyboard. The typewriter keyboard is equipped with 36 keys, plus controls for all the normal operations such as carriage return, backspace and tabulation.

Immediately above the typewriter keyboard is the much larger amount keyboard; this is divided into three sections. On the left are two columns of keys which control 10 adding registers contained in the machine. Totals and sub-totals are added and stored automatically in these registers. The central area of the keyboard is occupied by columns of numbered keys on which financial data are entered. Situated on the extreme right are the group of keys that control the operation of the machine.

The carriage carrying the platen on which the documents are held is situated above the key-

(Right) Entries are printed by the accounting machine on this set of five documents simultaneously

(Below) The National 461/2 paper tape punch connected to the accounting machine



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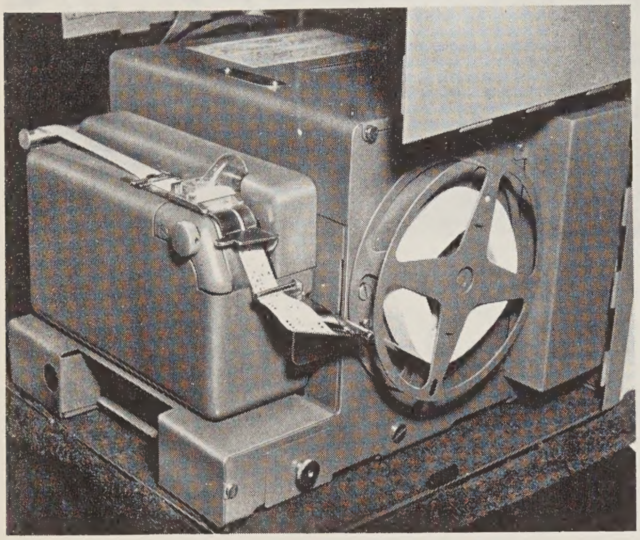
boards. On the front of the carriage is a control bar with adjustable stops. These are set to arrest the carriage automatically at each position on the particular document that an entry has to be made. The control bar is retained in position by two quick-release pins. Control bars are specially prepared for each routine clerical procedure.

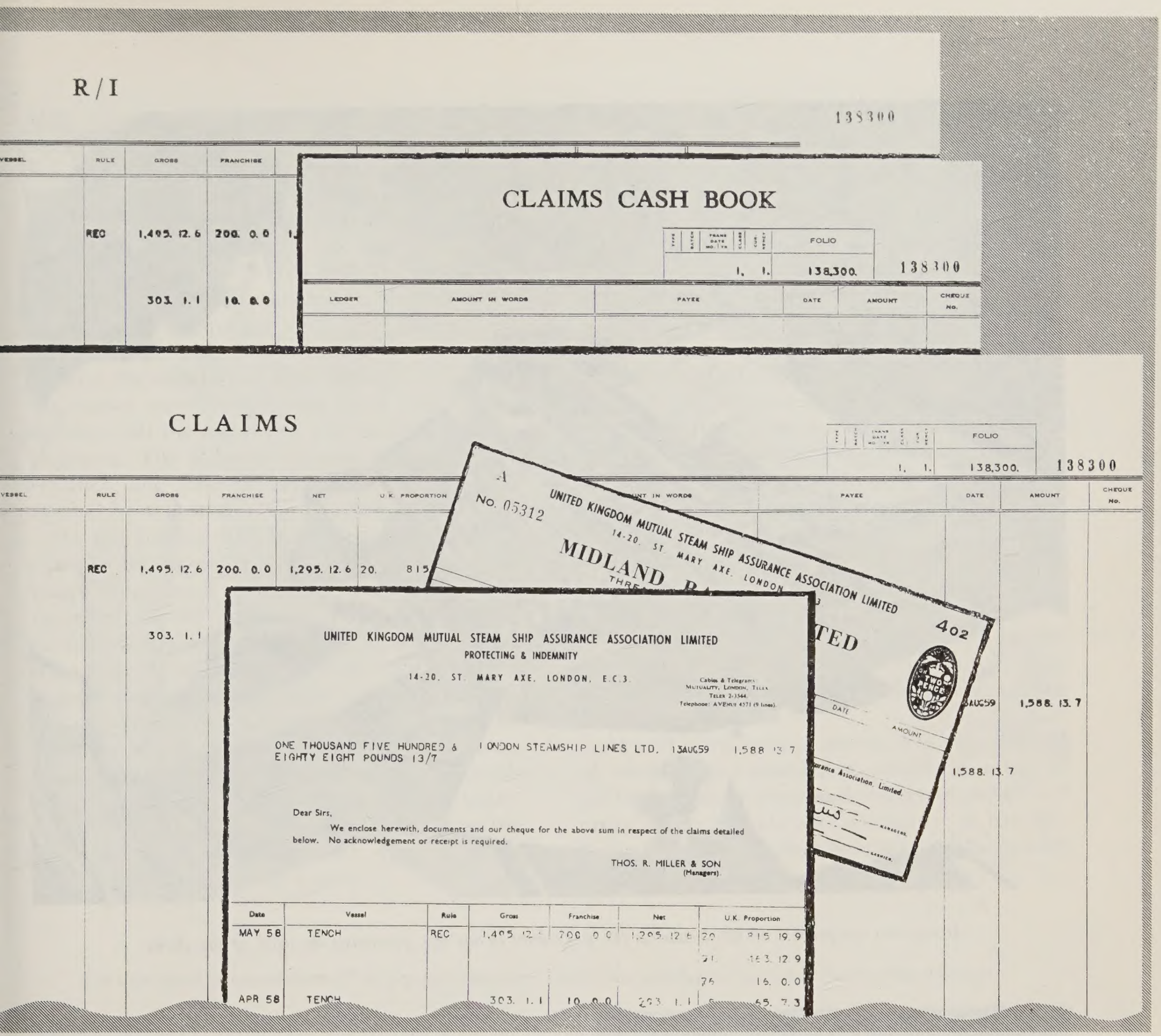
The type of automatic paper tape punch used by Thomas R. Miller & Son is the National 461/2. This is a small compact unit, measuring 10 inches high, 13 inches wide and 13 inches deep. A spool containing 1,100 feet of paper tape is fitted on the left of the unit and the tape is threaded through an electrically actuated punch to a take-up spool on the right. As stated earlier, this unit punches 5-channel paper tape; other units are available for punching wider tapes with 6, 7 or 8 information channels.



No matter what the work is, it is seldom necessary for all the data printed on a document to be reproduced on the paper tape. Consequently, fitted to the rear of the accounting machine carriage is a second control bar with cams that select the data that have to be punched. These cams turn the electrically driven tape punch on or off—"on" when the carriage has positioned the document at a column containing data to be recorded on the 5-channel paper tape.

Marine insurance work is by nature very complex. The United Kingdom Mutual Steam Ship Assurance Association, Ltd., consists of a group of shipowners who, as the name implies, cover their risks on a mutual liability basis. The money for all the claims paid in one year is subscribed by the owners in proportion to the tonnage they register with the Association and the risks represented by this tonnage. One of the major data processing tasks connected with this work is the payment of claims.

As claims are received they are first, of course, examined to see if they are valid. If they are accepted, the relevant data are entered manually on a special form. These are then passed to


R/I

CLAIMS CASH BOOK

CLAIMS

UNITED KINGDOM MUTUAL STEAM SHIP ASSURANCE ASSOCIATION LIMITED
PROTECTING & INDEMNITY
14-20. ST. MARY AXE. LONDON. E.C.3.

Cables & Telegrams: Mutuality, London, Telex
Telex 2-3544.
Telephone: AVEnue 4571 (9 lines).

ONE THOUSAND FIVE HUNDRED & EIGHTY EIGHT POUNDS 13/7 LONDON STEAMSHIP LINES LTD. 13AUG59 1,588 13 7

Dear Sirs,

We enclose herewith, documents and our cheque for the above sum in respect of the claims detailed below. No acknowledgement or receipt is required.

THOS. R. MILLER & SON
(Managers).

Date	Vessel	Rule	Gross	Franchise	Net	U.K. Proportion	
MAY 58	TENCH	REC	1,495 12 6	200 0 0	1,295 12 6	20	815 19 9
						21	163 12 9
						76	16. 0. 0
APR 58	TENCH		303. 1. 1	10. 0. 0	293. 1. 1	6	65. 7. 3

No. 05312

UNITED KINGDOM MUTUAL STEAM SHIP ASSURANCE ASSOCIATION LIMITED
14-20. ST. MARY AXE. LONDON
MIDLAND

the accounting machine operator who prepares all the necessary documentation in one operation.

Five documents with interleaved carbons are wound over the platen of the machine. The platen is 26 inches wide. The set of five documents comprises the cheque, the letter of payment, the claims abstract, a page for the claims cash book, and the reinsurance document. Of these, the reinsurance document and the claims abstract are the largest documents, the latter occupying almost the full width of the platen. When arranged in the machine ready for an entry to be made, the reinsurance document is the last document in the set. Immediately above this, but on the extreme right, is placed the claims cash book page. As this is approximately foolscap size, it will only cover a few columns located on the right-hand side of the largest documents and, consequently, only the data typed in these columns will be reproduced on the claims cash book page.

Immediately above the cash book page is the claims abstract. This is the widest document of all (25·75 inches) and is the only form on which will appear a record of all the data typed at one entry. Next is the letter accompanying payment. This is a quarto size document and covers the columns down the middle of the claims abstract form. Finally, attached to the top of the letter, is the cheque.

Having fitted the correct control bars to the machine, the operator enters, along one line, the data relating to the particular claim. This information is obtained from the hand-written

An operator can prepare all the documents for 300 claims in one day: previously the work of five clerks

forms prepared previously. In the first columns of the documents are entered: Class, owner's number, nationality, year, and so on. As these are entered, they are automatically reproduced on the documents beneath by means of the carbons. After each entry is made, the operator touches the "motor bar" and the carriage of the accounting machine automatically brings the next column on the document into position ready for the next entry—and so on, until the entry of the claim has been completed.

Some of the entries are, or can be, made automatically. For example, certain figures are totalled and stored in the different adding registers of the machine as they are entered in the columns, and when one of the totals is to be printed on the document, a cam on the control bar causes this to occur automatically. Alternatively, the appropriate register key can be depressed by the operator.

One automatic entry made in this way is the net value of each claim. A "deductible franchise," the value of which depends upon the type of claim, the owner and the insurance cover, is printed in one column and this value is subtracted automatically from the gross claim and the net figure automatically printed on the document.

Yet another example is the addition of all the separate claims made by one owner. The value of the separate claims is stored in one of the adding registers and, on completion of the claims document, the total is automatically printed at the bottom of the page. In another register, the total of all claims handled in a day is stored for accountancy control purposes; this figure is printed automatically at the end of each day for comparison with the control total.

When all the claims for one owner have been entered on the documents and the total compiled, the cheque is prepared. For this operation, the cheque and the letter to which it is attached are moved to the extreme right of the claims abstract form. The amount to be paid is then printed on the cheque by the machine. This total will be reproduced on the documents underneath, one of which will be the claims cash book page. With this action, the operation of recording a sequence of claims made by one owner is concluded.

After the cheque has been signed, it is sent to the owner together with the letter which gives details of all the individual claims settled by the payment. The three remaining documents are retained, and these provide the internal records needed by the office.

As the individual claims are prepared, the cams on the second control bar trigger the automatic tape punch so that selected data will be recorded on the 5-channel paper tape simultaneously. Claims data that are recorded in this way are: Class, currency, owner's number, vessel's flag and trade, form of ship's articles, voyage, year, type of claim and the individual amounts of each claim. From this information, an analysis of claims is prepared on the National-Elliott 405 computer. Claims are grouped under a number of combined headings requiring the compilation of about 165,000 separate totals throughout the course of a year.

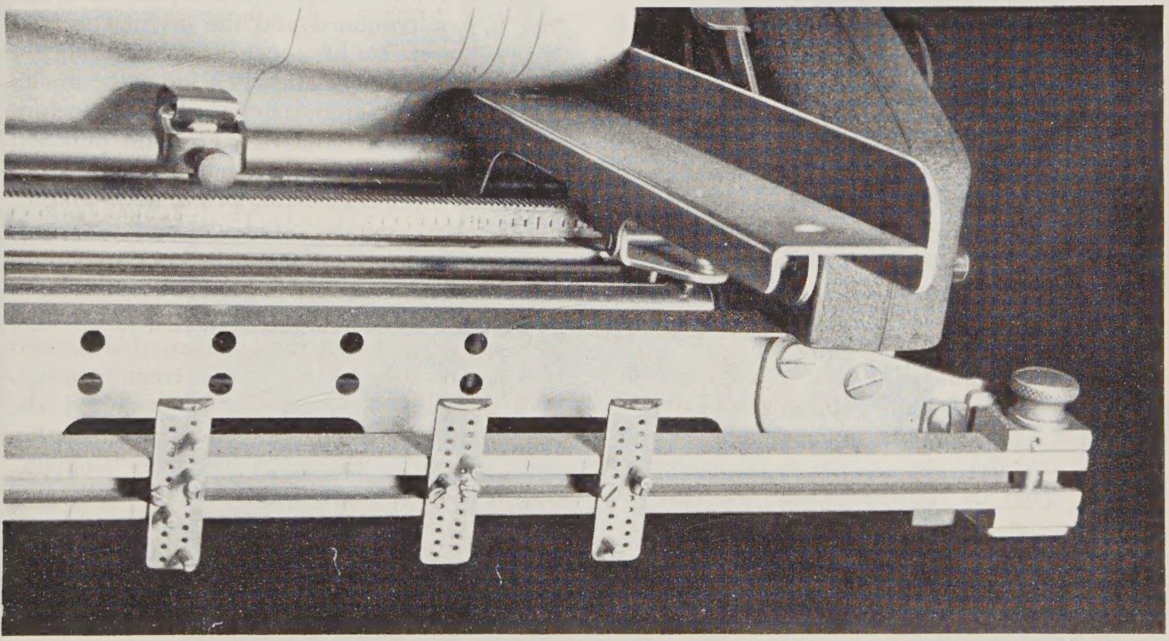
Statistics form an essential part of insurance work because, of course, they provide the information on which future risks can be assessed. In marine insurance of this type, the number of headings under which claims are analysed is extensive. For instance, the insurance association mentioned in this article represents 20 million tons of shipping sailing under 56 different flags.

Risks are classified under 34 separate headings. Previously, it had not been possible to complete an analysis of all claims under these 34 headings because the amount of work involved would have been prodigious and certainly far beyond the capacity of the clerical staff available. Now that the figures are produced by a computer there is no reasonable limit to the statistics that can be prepared, once the computer programmes have been written.

Since the accounting machine was installed in June, 1958, all the work of recording claims has been transferred to the machine and two similar machines are being obtained to handle data connected with other aspects of marine insurance work.

As will have been gathered, the new method of working has enabled a smaller number of staff to handle an increased volume of claims and every claim is dealt with promptly; it has also helped the management by providing them with statistics of immense value.

The tape punch is turned on or off by peg-type cams on a control bar attached to the rear of the machine carriage



Automatic selection and reproduction of industrial documents

Composite system using microfilms, punched cards and xerographic printing

By a combination of three established techniques it is now possible to reduce the demands on office accommodation for filing documents, including engineering drawings, and at the same time speed up the provision of the precise material required. In the system discussed, the three techniques are interdependent: compact filing facilities are provided by microfilming all records; rapid retrieval of selected documents is achieved by the employment of punched cards and full-size copies of the documents are produced, rapidly, by xerographic printing

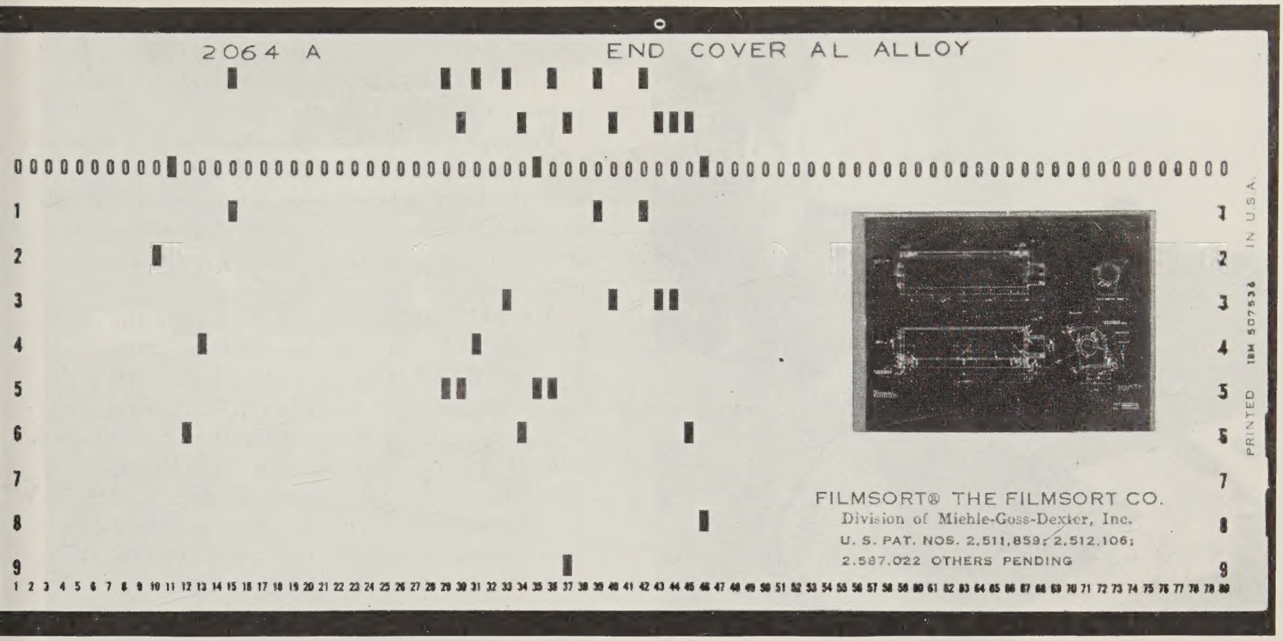
THIS system is extremely simple in concept. Documents to be held on file are microfilmed. Each individual picture is cut off the reel of microfilm and mounted over a special aperture cut in a standard 80-column punched card. Data identifying the microfilm are punched in columns available on the card. When the document is to be reproduced, the appropriate card is selected from the file of cards either manually or automatically by conventional punched-card techniques. The card is placed in a special projector mounted on a xerographic printer—the "Copyflo"—and the required number of full size documents is printed automatically at a speed of 20 feet a minute.

Although it has been stated that the individual pictures are mounted on punched cards, obviously they can be mounted on any other form of document or data processing card—for example, edge-punched cards. A company in the United States—The Filmsort Company—originated the idea of mounting microfilm pictures in this way so that documentary records could be retrieved easily and quickly with the use of conventional data processing equipment and techniques.

It is anticipated that initially this system will be used, in the main, for filing and reproducing engineering drawings. Other documents can be handled equally well, but the financial savings accruing from the elimination of a library of conventional engineering drawings are so large that this will obviously prove to be the most worth-while application.

When a draughtsman has completed a drawing it is microfilmed and the original is filed away, never to be touched again unless a correction or design alteration has to be made. The microfilm picture is mounted in an aperture at one end of a standard 80-column punched card and becomes the master document from which all other engineering prints are produced.

The part number and description which identify the drawing are punched in the columns on the left of the card before the microfilm is attached. This composite card, frequently called a Filmsort card after the company that devised this system, is stored in a file of current drawings. When copies of the drawing are required, the card is selected from the file and put, together with others, in the magazine of a "Copyflo" machine. Each card is fed automatically into the machine and, according to the number set on a control dial, the required number of copies are printed on a continuous roll of plain white paper. Each print is guillotined from the roll as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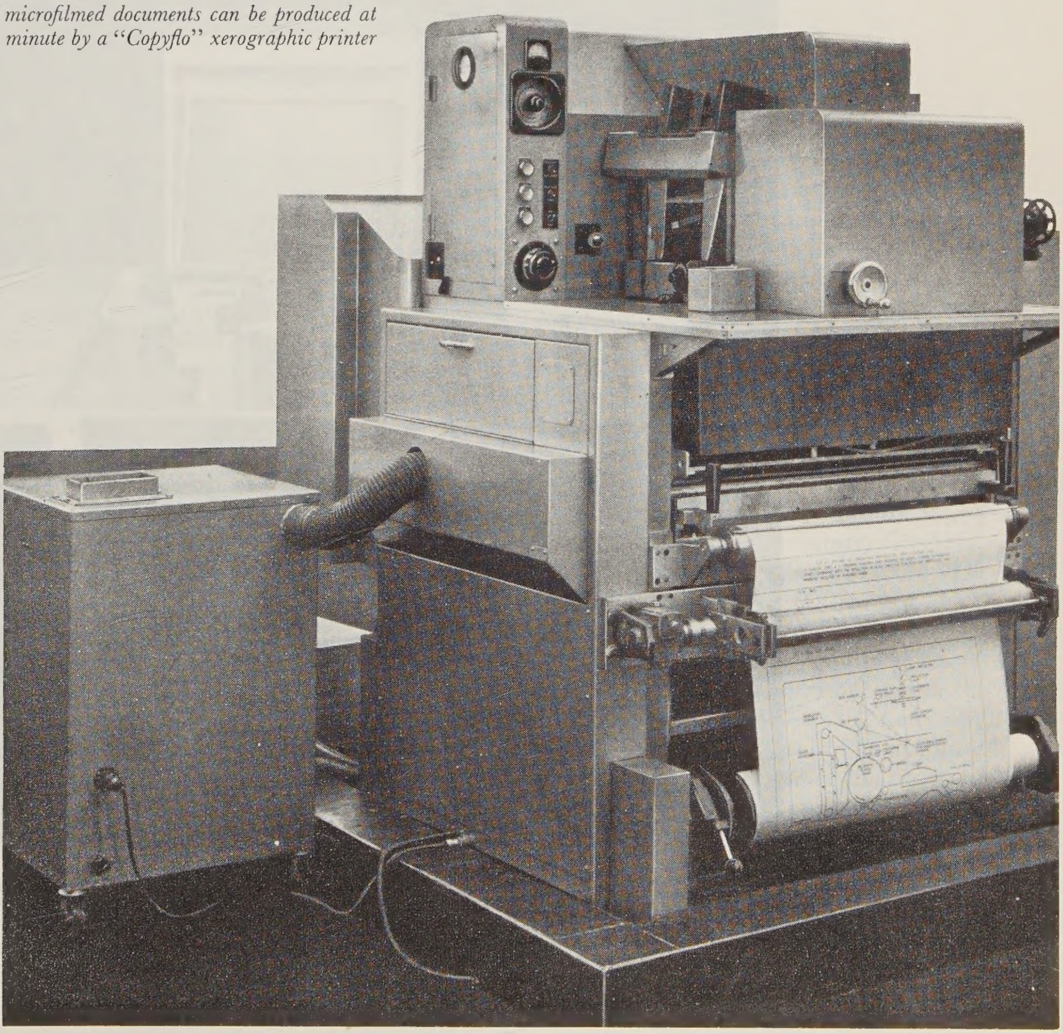
2,587,022 OTHERS PENDING
PRINTED IN U.S.A.
IBM 507536

An original document is microfilmed and the picture is mounted over an aperture in a punched card. Data identifying the document are punched into the card

Full-size copies of microfilmed documents can be produced at a rate of 20 feet a minute by a "Copyflo" xerographic printer



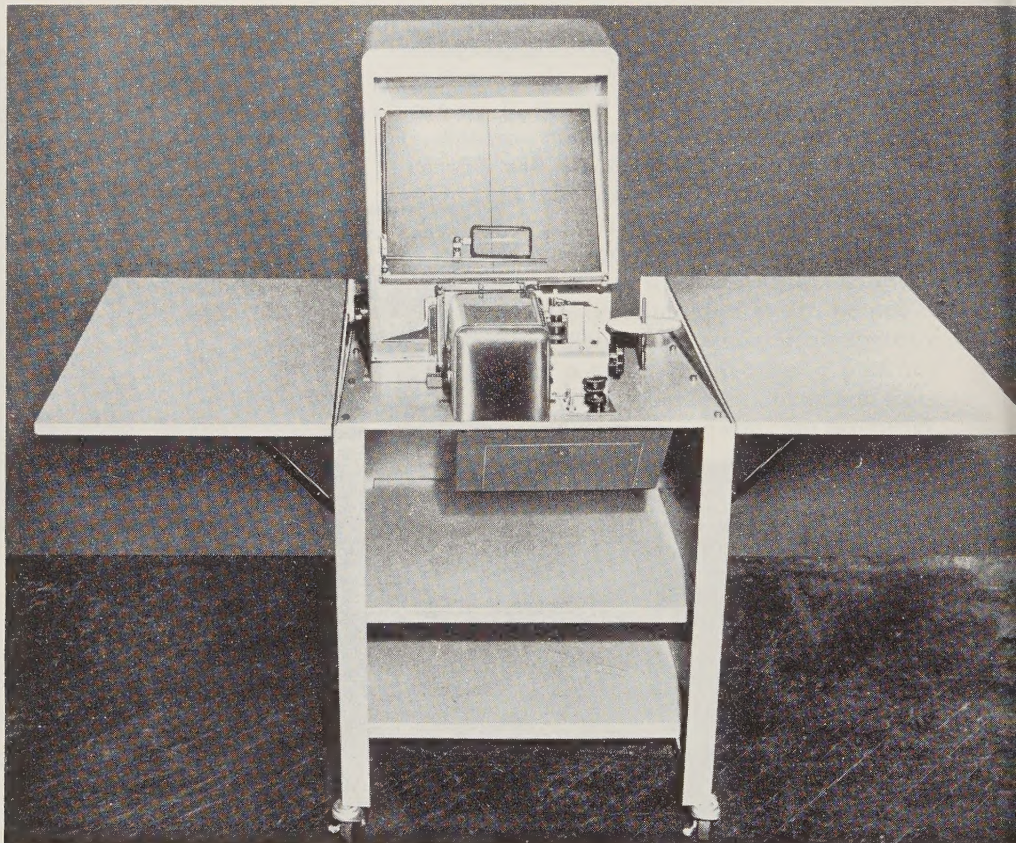
A portable manually operated machine for mounting microfilm pictures on punched aperture cards. Average mounting rate—400 frames an hour

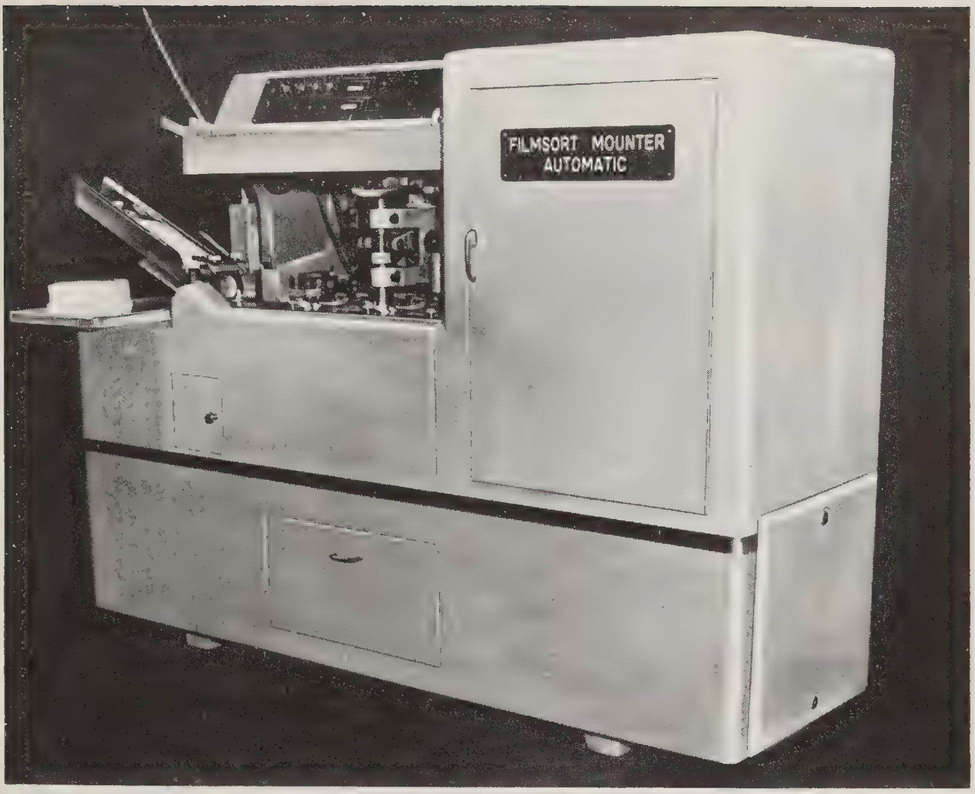
it emerges from the machine. The print is then ready to be issued. Afterwards, the card is returned for filing. As the cost of printing is low, prints can be discarded after use.

Perhaps the biggest advantage of this system is the saving of office space. About 2,000 square feet are required to house a library of 600,000 drawings. This can be reduced to approximately 50 square feet, if all drawings are recorded on microfilm.

Another, and obvious, advantage of the cards is that they can be handled by automatic equipment and they are not so bulky. To pick-out a Filmsort card and place it in the magazine of a "Copyflo" is far simpler than selecting a full-size tracing and feeding it through a dyeline printing machine. Also costs in other directions are reduced. With the conventional method, a draughtsman's drawing has first to be traced on linen to provide the master document from which copies can be reproduced. With the new method the original drawing is photographed

Semi-automatic mounting machine. The film is fed to the approximate position, it is centred manually, then mounted on the card automatically





A completely automatic machine which mounts 2,000 *microfilm frames an hour*

and copies are obtained directly from the microfilm. The draughtsman, however, has to exercise care to ensure that all lines are firmly drawn and letters are large enough to be legible when reproduced, possibly on a smaller scale.

Already the system is operated by several major engineering companies in the United States and others are in the process of adopting it. The necessary equipment is built in Great Britain with the exception of machines for mounting the microfilms on the cards. These are imported, at present, and marketed by the Recordak Division of Kodak Limited and Rank-XeroX Limited. Kodak manufacture the microfilming equipment and Rank-XeroX build the high-speed "Copyflo" xerographic printers.

The cards used are specially prepared. An aperture of the correct size is punched in an 80-column card and surrounded with an adhesive strip. This strip is protected by a piece of paper, which is removed from the card just before it is placed in the mounting machine. The size and position of the aperture in the card varies, but for 35mm microfilm and 80-column cards an attempt is being made to standardize what is termed a "D" size aperture. This measures $1\frac{9}{16}$ inches by $1\frac{5}{8}$ inches, spans columns 54 to 76 on the right of the card and, relative to the width, is situated in the middle. A document measuring 30 inches by 40 inches can be recorded on a film framed by this aperture. Data identifying the picture are punched in the remaining 50 or more columns on the left of the aperture

Obviously, if this method of filing and reproducing engineering drawings is adopted universally it will be advantageous to have a standard so that cards can be interchanged freely—passed on to sub-contractors, licensees, and so on, in the form of perhaps complete libraries. A point here is that the cards can be despatched conveniently through the post

Several machines of varying complexity are available for mounting microfilm on the cards. The simplest of these is a small manually operated, portable unit. The reel of microfilm is placed on a spindle at the rear of the machine and passed behind a viewing aperture. A prepared punched card is slipped into the slot between the two. Then the microfilm picture is illuminated and its position relative to the card adjusted by means of a knurled handwheel. Upon a lever being operated, the picture is guillotined from the roll of film and pressed against the adhesive edge that surrounds the aperture. The card complete with microfilm picture is now ready to be removed from the machine.

With this unit an operator is able to prepare, on average, 400 cards an hour and an experienced operator can mount as many as 600 pictures an hour.

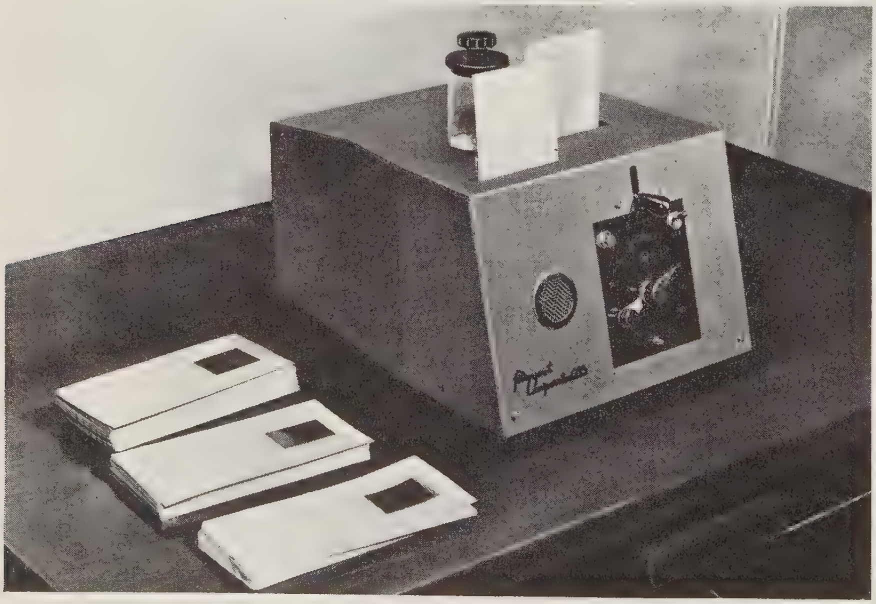
Where large quantities of cards have to be prepared, to reduce operator fatigue, a semi-automatic film mounting machine may be used. This machine is equipped with a viewing screen measuring 14 inches by 14 inches on which the microfilm picture is projected, magnified eight times. The microfilm is fed from its storage reel automatically, the punched cards are inserted by hand and the lateral position of the picture is adjusted by the manual operation of a control knob. When, lastly, a control button is pressed, the picture is cut from the roll of film and mounted on the card automatically. As with the manually operated portable machine, an average of 400 cards can be prepared in an hour.

Where considerable numbers of microfilm pictures are to be mounted, a completely automatic machine is used. Blank cards are fed into the machine together with the continuous strip of microfilm. The protective paper is stripped from the card and the microfilm picture is centred over the aperture, guillotined from the roll and mounted on the card in one automatic operation. Cards are prepared on this machine at the rate of 2,000 an hour. The Filmsort Automatic Mounter can handle continuous rolls of microfilm up to 1,000 feet in length. Safety circuits switch the machine off should any irregularity in the microfilm or the card be detected.

An essential item of ancillary equipment, where the cards are to be used as a means of transferring engineering data from one firm to another, is the automatic card-to-card printer. Microfilmed records mounted on cards can be reproduced automatically by this machine at the rate of 900 an hour.

Xerographic printing

A piece of equipment that is fundamental to the operation of the system is the high-speed xerographic printer—the "Copyflo" (Model 5B). This machine enables full size prints to be obtained directly and rapidly from the microfilm pictures. The principle of continuous printing by xerography has already been described in detail in *Data Processing.** In essence



Duplicate copies of Filmsort cards can be produced by this manually operated card-to-card printer

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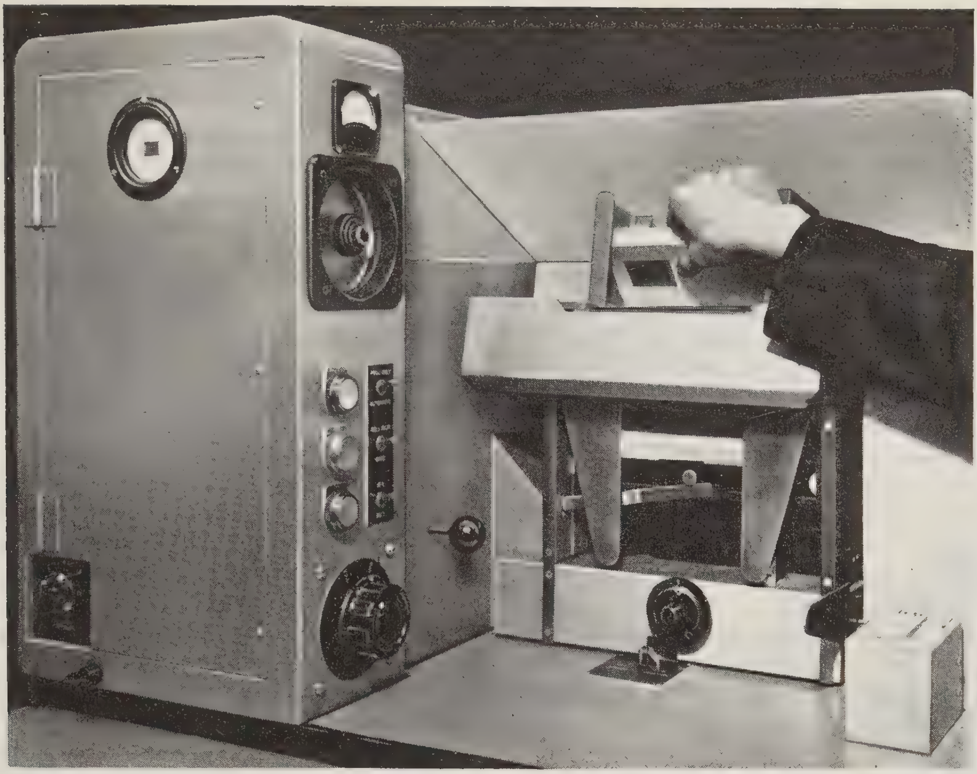
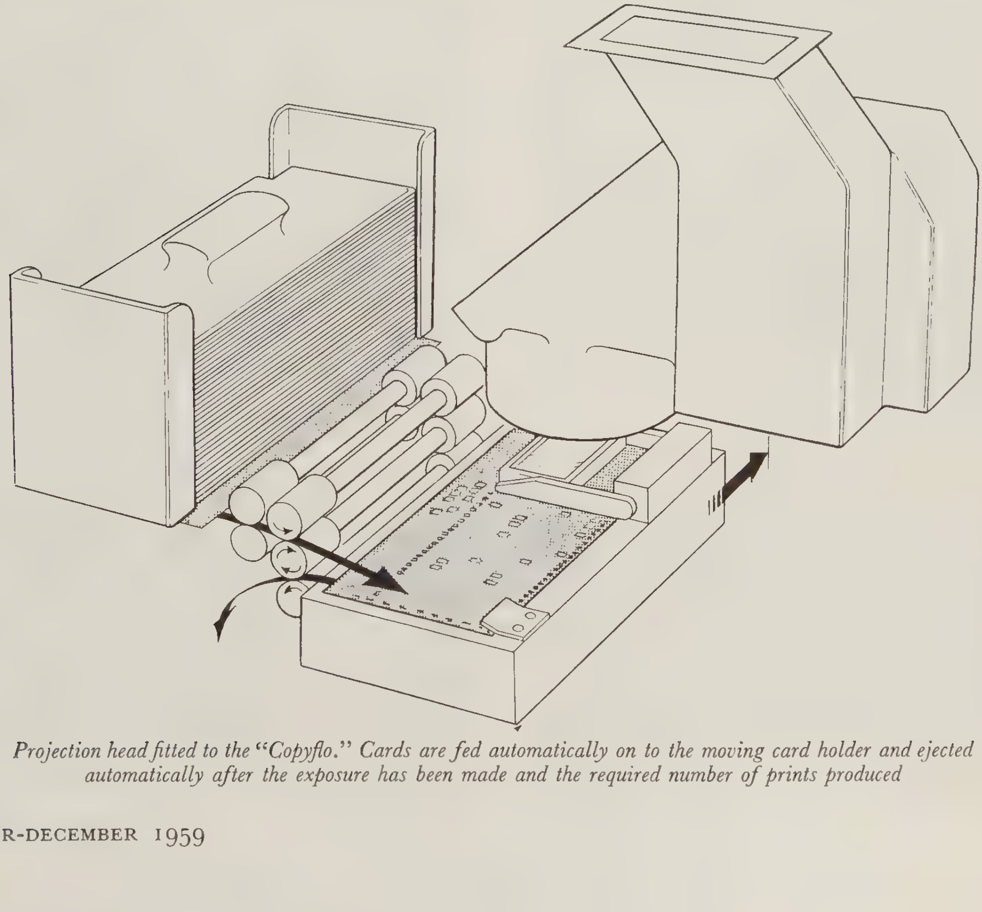
*"High-speed printing," *Data Processing*, page 54, January-March, 1959. The "Xeronic" is marketed by Rank Precision Industries, Ltd., Sulgrave Road, London, W.6, and the "Copyflo" by Rank-XeroX, Ltd., 33 Mortimer Street, London, W.1.



Up to 500 cards can be loaded in the magazine of the "Copyflo" printer, which can produce from one to 400 copies of each document



Projection head fitted to the "Copyflo." Cards are fed automatically on to the moving card holder and ejected automatically after the exposure has been made and the required number of prints produced the "Copyflo" is identical with the "Xeronic" computer-output printer except that a special head for the projection of mounted microfilm pictures is fitted in place of the cathode-ray tube and electronic circuits.

A batch of up to 500 Filmsort cards can be placed in the magazine of the machine. Then a control dial is set by hand at the number of copies required—anything from one to 400—and the machine is switched on. It is best if a batch contains cards from which the same number of copies are to be printed, then the operator does not need to be in constant attendance to change the setting of the control dial. Cards are fed into the machine from the magazine, one at a time. The required number of copies is printed and, on completion, the particular card is ejected into an output hopper. Simultaneously, the next card is fed into the machine from the magazine. This sequence is repeated until all the cards have passed through the machine, whereupon the machine switches itself off.

When a card is fed into the machine, it is positioned in a card holder. A powerful light projects the image of the microfilm picture on to the surface of the rotating selenium-coated drum. To compensate for the continuous movement of the drum, the card holder is moved mechanically at a fixed speed during the exposure. After an exposure, the card holder is returned rapidly to its starting position and, if another copy of the same document is required, the process is repeated.

The image of a document may not occupy the full width of the microfilm picture. Consequently, a hand control is provided on the machine by which the length of travel of the card holder can be adjusted to suit the length of the document being printed. This adjustment enables copies to be printed adjacent to each other without large intervening gaps of plain paper, so avoiding wastage of material and also machine operating time.

The larger forms of engineering drawing (usually about 45 inches by 30 inches) can be successfully photographed on 35mm film but cannot be reproduced full size. The reels of paper that can be fitted to the "Copyflo" may be up to 26 inches wide with a maximum printing width of 24 inches. There is, however, no restriction, as far as printing is concerned, on the length of a print. Consequently, the largest engineering drawings are reproduced at a size of 36 inches by 24 inches. Microfilm records are reproduced at one of two fixed values of magnification, × 15 or × 20. The particular value is selected manually before the start of a printing sequence.

In addition to being able to handle Filmsort cards, this special version of the "Copyflo" is also equipped to print from a continuous roll of microfilm. The machine costs £28,800 or may be rented at £600 per month. To assist companies to establish this new technique and avoid a large capital investment when utilization is low, "Copyflo" machines can be hired on a meter basis with payment depending on the number of feet of paper printed.

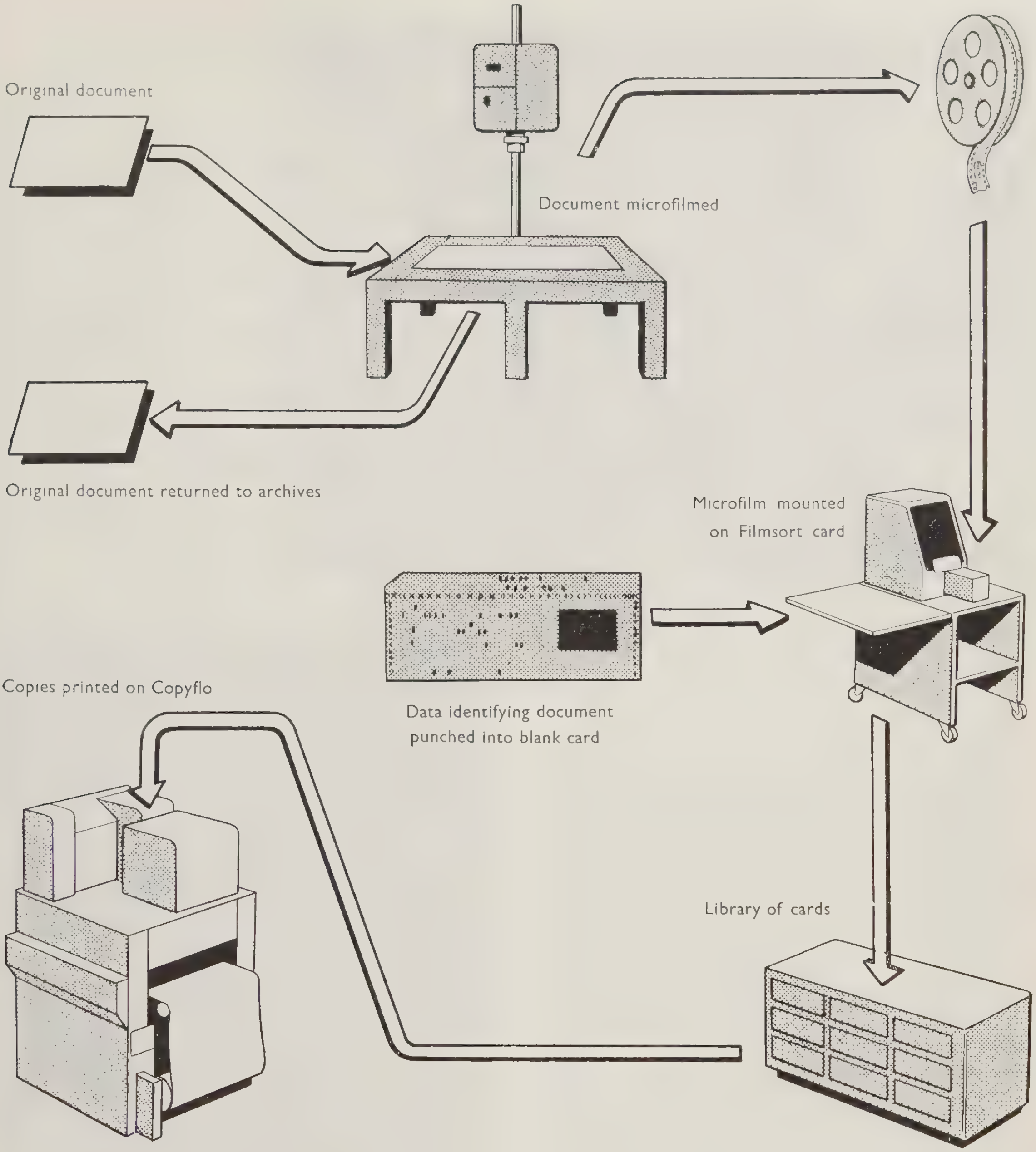
16,000 prints a day

It has already been mentioned that this system has been adopted in the United States. An example is the East Pittsburgh Division of the Westinghouse Electric Corporation. The procedure adopted is as follows:—

Original drawings produced by the drawing office are sorted into sizes, entered on a list in sequence and sent to be microfilmed. After being photographed, the drawings are stored in a vault. Data from the drawings list are keypunched into blank Filmsort cards. These facts include drawing number, size, date, microfilm roll number and product code number. This information is printed along the top of the card in addition to being punched into the card. Then these pre-punched cards, in sequence—the same drawings list sequence as that in which the drawings are photographed—are fed into a semi-automatic mounter by an operator and the microfilm pictures attached. As an additional safeguard, the operator checks that the drawing number recorded on the card agrees with that on the microfilm picture projected on to the viewing screen. Completed cards, in drawing number order, are then filed manually in the library of engineering drawings.

When requests for copies of drawings are received, the appropriate cards are selected from the file by hand and sent to a "Copyflo" machine which produces the required prints.

Although Westinghouse instituted this system only last year, they anticipate that by the end of 1959 they will have 500,000 drawings available on Filmsort cards. Experience is that each year more than 30,000 drawings are made and over 54,000 existing drawings are revised by the 400 draughtsmen employed at the East Pittsburgh division. Requests for drawings average 3,000 a day, involving the production of approximately 16,000 engineering prints.


Original document
Document microfilmed
Original document returned to archives
Microfilm mounted on Filmsort card
Data identifying document punched into blank card
Copies printed on Copyflo
Library of cards

By adopting this method of reproducing drawings, Westinghouse have, of course, eliminated the need for tracings; they have also saved 10,500 square feet of floor-space. Costs of drawing-office supplies have been reduced by £18,000 a year, largely because linen tracing cloth is no longer required. Also the cost of reproducing drawings has been reduced by approximately £45,000 per annum.

These large savings reflect the scale of the operation but Westinghouse consider that proportionate savings can be made in smaller engineering works. They intend to extend the system so that prints will no longer be necessary in the drawing office. Ultimately, each draughtsman will be supplied with a desk-top microfilm projector and a duplicate file of Filmsort cards will be stored in the drawing office.

If this system is adopted in Great Britain and the demand from smaller companies is sufficient Rank-XeroX will establish a microfilm and Filmsort card printing service.

Magnetic tape

–the commercial document of the future

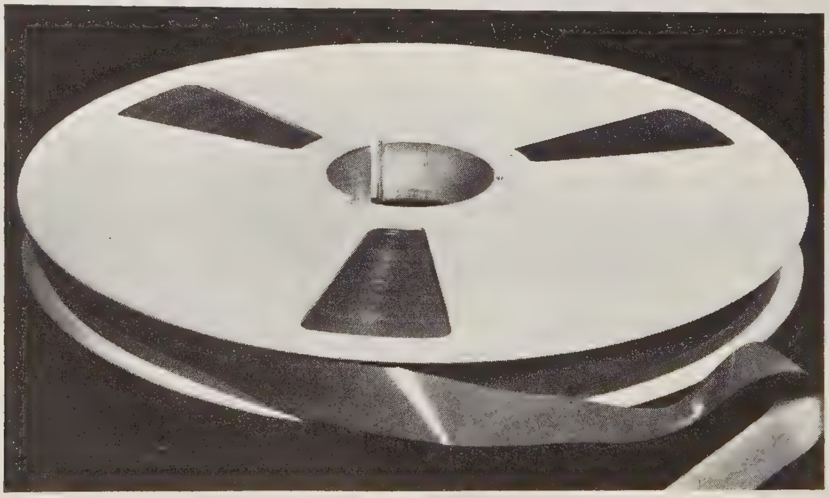
- **Magnetic tape provides bulk information storage capacity**
- **Data can be obtained from or recorded on magnetic tape faster than any other medium yet devised—20,000 characters or more per second**
- **The tape is compact, inexpensive and can be re-used any number of times**
- **3,500 feet can be stored on a reel 10½ inches in diameter**
- **100 characters, or more, can be recorded on every inch of tape**
- **Recorded data does not depreciate nor is it easily destroyed**
- **The major disadvantage is that data recorded on magnetic tape cannot be read by eye**

MAGNETIC tape will become the office document of the future wherever electronic methods of processing data are used. There are two principal reasons why this is so. One is that magnetic tape provides a compact and inexpensive means of storing large quantities of data. Secondly, data can be obtained from magnetic tape faster than from any other type of document that can be read automatically.

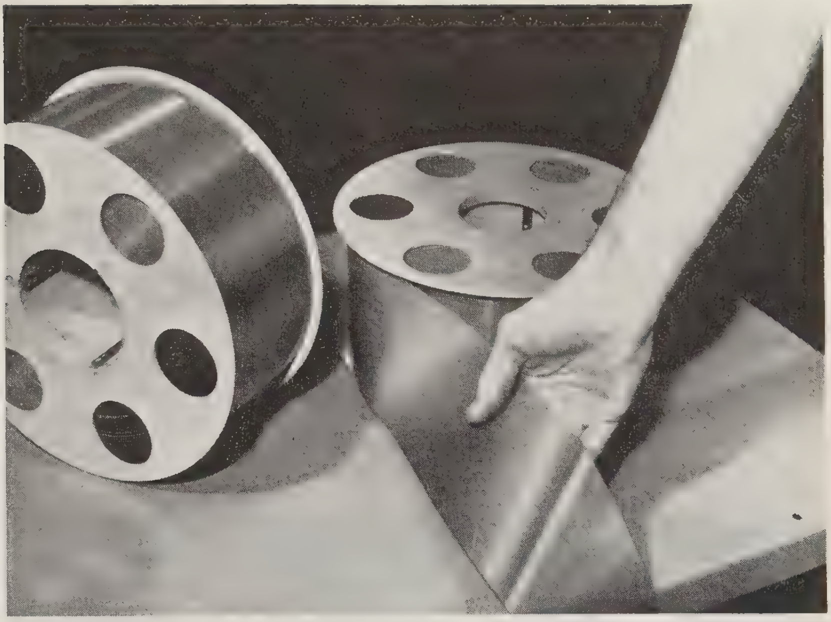
As is well known, a distinguishing feature of commercial work is the large volume of data handled on which, in general, only a few simple arithmetical operations have to be performed. Consequently, electronic digital computers designed for commercial work must be able to store considerable quantities of data. Magnetic tape provides this bulk information storage capacity. To distinguish such systems from mathematical computers it is becoming the convention to refer to them as electronic data processing systems.

A computer of medium speed can perform 180,000 additions or 30,000 multiplications in each minute. If the capabilities of such a machine are to be utilized to the full, some means of feeding data into it at a high speed is a necessity. Also, of course, it is equally necessary that results obtained should be recorded at as high a speed as possible so that the operation of the machine is not slowed up. In both respects, magnetic tape is the best medium so far discovered for this purpose.

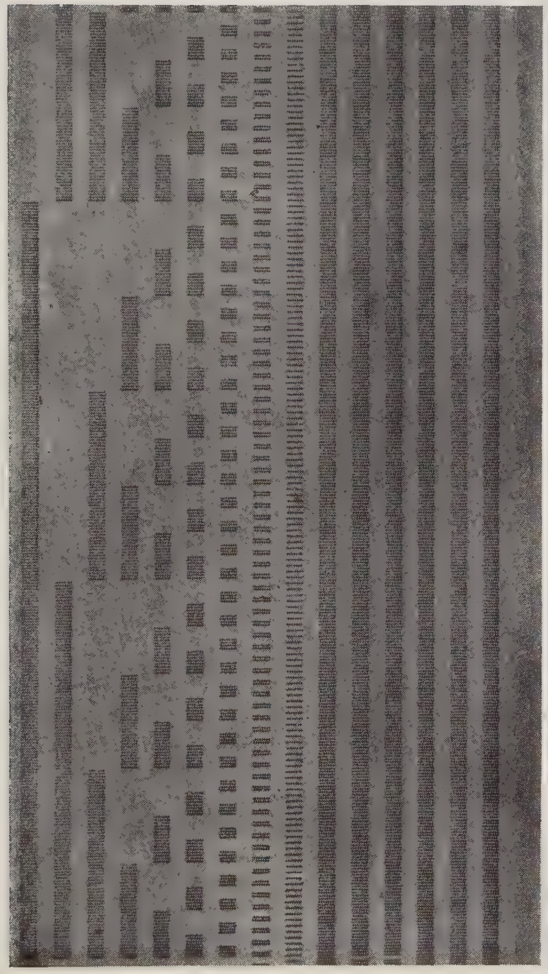
Magnetic tape 1 inch wide stored on a reel 14 inches in diameter. Up to 24 tracks can be recorded on 1 inch tape



(Right) A contrast in size. Magnetic tape 4 inches wide is used to provide bulk data storage capacity in the Emidec 2400 computer



(Below) Digital data are recorded on tape as a pattern of magnetized spots. Here, illustrated at an enlarged scale, the recordings on a segment of tape have been made visible by sprinkling iron filings over the oxide surface



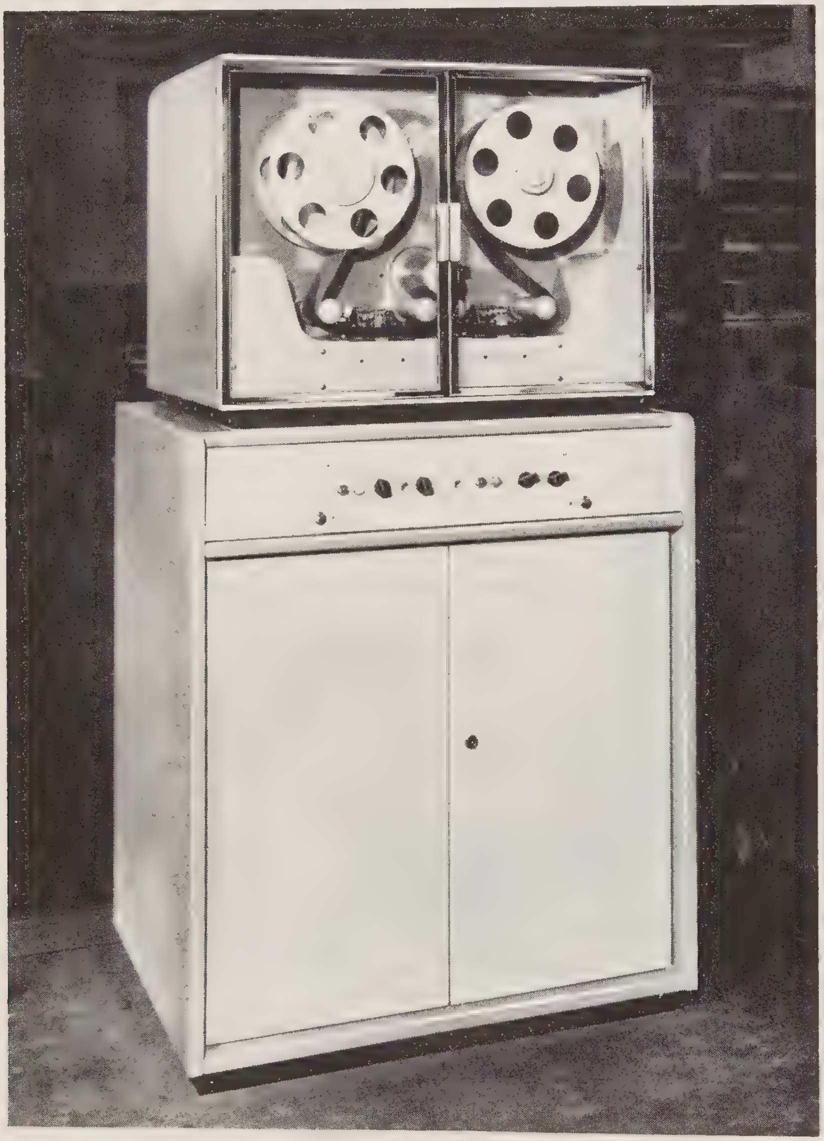
Another advantage possessed by magnetic tape is that it can be wound on a reel: in this form it is readily transportable. Yet another feature is that reels can be removed easily from the computer and stored until required at some future date. In addition, magnetic tape is cheap, having regard to the amount of information that can be recorded on it.

Any document employed in business must, of course, be reasonably tough and durable. Magnetic tape fulfils these requirements. Data can be recorded and stored on it for an indefinite period without deteriorating. The recorded information will not be affected by mishandling or by the majority of accidents that can befall the tape. For example, data need not be lost if the tape is dropped, even though the reel on which they are stored may be damaged. Of course, tapes can be destroyed by fire; however, they are no more vulnerable in this respect than the paper records they replace. Recorded data will also be destroyed if the tape is placed in a powerful magnetic field, although under normal working conditions this is hardly likely to occur.

Naturally, tapes will last longer if stored carefully. Cleanliness is most important together with the prevention of mechanical damage to either the reel or the tape.

Magnetic tape possesses all the characteristics expected of modern business documents except one—the information recorded cannot be deciphered by human beings. However, this impediment is outweighed by the advantages.

Use of magnetic tape implies that means are available for recording data directly on to tape. In Great Britain the development of magnetic tape units has been somewhat slow. Initially, magnetic tape has been used only to provide bulk information storage capacity. It has not been used as a means of feeding new data to a computer; consequently, very few magnetic tape data transcription units are yet available. However, this need is appreciated and several types of transcription unit are being developed. These range from keyboard machines, ones that record data on the magnetic tape as it is manually typed, to other units that read data from punched cards or punched tape. At present, in many computer systems the only way of getting data on to tape is to use the computer itself. Data are read from punched cards or punched tape in the usual way and routed through the computer to one of the magnetic tape storage units where they are recorded. To use a computer in this way is uneconomic.



The 4-inch magnetic tape unit of the Emidec 2400 data processing system. Data can be read from the tape at a speed of 20,000 characters a second

Physically, magnetic tape is a continuous ribbon of material that can be magnetized. In some cases the tape is metallic, but more frequently it consists of a plastics material that is coated on one side with a metallic layer, usually about 0·0005 inches thick. The magnetic material preferred nowadays is iron oxide which gives magnetic tape its characteristic brown colour. Magnetic tapes are made in several different widths and for computer applications these vary between ¼ inch and 4 inches.

Data are recorded on magnetic tape as a series of pulses representing binary digits, or bits.* The act of recording data on tape is known as writing and the converse operation of obtaining data from the tape is known as reading. Reading and writing on the tape is done by magnetic heads. Sometimes different magnetic heads are used for reading and writing, but the same head can perform both functions. Several magnetic heads are placed next to each other across the width of the tape. As the tape passes underneath a battery of magnetic heads and data are written on it, a number of narrow tracks are formed extending along the length of the tape. The number of tracks that can be recorded on a tape depends on the width of the tape, the design of the magnetic heads and the quality of the recording required. Generally, from 15 to 24 tracks are recorded on tape one inch wide.

Types of magnetic head

There are two basic types of magnetic head: that placed in direct physical contact with the tape and that which operates with a small air gap between tape and head. Advantages possessed by the in-contact heads are that more pulses can be recorded along each inch of track and the signal induced in the magnetic head during a reading sequence is much stronger by virtue of the fact that the head is so close to the magnetic coating on which the pulses are recorded.

Disadvantages of this arrangement are that, with any form of direct mechanical contact, wear takes place. Also, if the surface of the tape has a raised imperfection, or a grain of dirt adheres to it, this will temporarily force the head out of contact, with the result that data will be lost. To reduce this risk to a minimum, magnetic tapes are subjected to a stringent inspection during manufacture and the magnetic tape units are enclosed in dust-proof air-conditioned cabinets.

Advantages and disadvantages of out-of-contact heads are the reverse of those just discussed. Fewer pulses can be recorded along a given length of track, but the chances of losing information because of mechanical imperfections in the tape or the ingress of dust into the magnetic tape unit are reduced. Cleanliness is, however, still of great importance and units of this type are also completely enclosed and supplied with filtered air.

Magnetic tape on the Emidec 2400

As has been already stated, data are recorded by a sequence of pulses in the individual tracks of the tape. Special codes have been devised in order that both numerical and alphabetical information can be recorded in a concise way. As the exact manner in which this is done differs from one magnetic tape unit to another and also from computer system to computer system, a particular system will be described. The one chosen is the Emidec 2400, a fast general-purpose machine suitable for either business or scientific work.

Two types of magnetic tape unit are fitted and both are used to provide bulk information storage capacity. One type is equipped with magnetic tape one inch wide, and the other with tape four inches wide. The same code is used for recording data on both of these tapes, but the description that follows only refers to the unit using one-inch tape.

Twenty-four recording tracks are provided across the width of the one-inch tape. The magnetic reading and writing heads are grouped in two blocks of 12 that are interleaved. When the tape is transported in one direction, one block of magnetic heads is used and when the tape moves in the reverse direction the other block is used. In consequence, at any one time information is being read from, or recorded upon, 12 tracks simultaneously.

Commercial data are recorded upon six of the 12 tracks available, four tracks are used for checking purposes and the remaining two tracks are "clock" tracks. These synchronize the tape with the computer system when reading or writing is performed. Pulses are recorded in rows across the six data tracks. A pulse may or may not appear in any one of the six data tracks and, by the use of a suitable code, any

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*A simple explanation of binary notation is given in the article "The Universal Language of Computing," *Data Processing*, January-March, 1959.

Character	6 - bit code					
SPACE	○	○	○	○	○	○
A	○	○	○	○	○	●
B	○	○	○	○	●	○
C	○	○	○	○	●	●
D	○	○	○	●	○	○
E	○	○	○	●	○	●
F	○	○	○	●	●	○
G	○	○	○	●	●	●
H	○	○	●	○	○	○
I	○	○	●	○	○	●
J	○	○	●	○	●	○
K	○	○	●	○	●	●
L	○	○	●	●	○	○
M	○	○	●	●	○	●
N	○	○	●	●	●	○
O	○	○	●	●	●	●
P	○	●	○	○	○	○
Q	○	●	○	○	○	●
R	○	●	○	○	●	○
S	○	●	○	○	●	●
T	○	●	○	●	○	○
U	○	●	○	●	○	●
V	○	●	○	●	●	○
W	○	●	○	●	●	●
X	○	●	●	○	○	○
Y	○	●	●	○	○	●
Z	○	●	●	○	●	○
&	○	●	●	○	●	●
Spare	○	●	●	●	○	○
Carriage return	○	●	●	●	○	●
Line feed	○	●	●	●	●	○
?	○	●	●	●	●	●
0	●	○	○	○	○	○
1	●	○	○	○	○	●
2	●	○	○	○	●	○
3	●	○	○	○	●	●
4	●	○	○	●	○	○
5	●	○	○	●	○	●
6	●	○	○	●	●	○
7	●	○	○	●	●	●
8	●	○	●	○	○	○
9	●	○	●	○	○	●
10	●	○	●	○	●	○
11	●	○	●	○	●	●
SPACE	●	○	●	●	○	○
Spare	●	○	●	●	○	●
.	●		●	●	●	
Spare	●	○	●	●	●	●
—	●	●	○	○	○	○
→	●	●	○	○	○	●
(	●	●	○	○	●	○
)	●	●	○	○	●	●
>	●	●	○	●	○	○
≥	●	●	○	●	○	●
=	●	●	○	●	●	○
Spare	●	●	○	●	●	●
≠	●	●	●	○	○	○
£	●	●	●	○	○	●
+	●	●	●	○	●	○
Spare	●	●	●	○	●	●
/	●	●	●	●	○	○
Carriage return	●	●	●	●	○	●
Line feed	●	●	●	●	●	○
*	●	●	●	●	●	●

Any character whether figure, letter or symbol can be represented by a pattern of magnetized spots arranged in rows across the magnetic tape. Above is the 6*-bit code used in the Emidec* 2400 *data processing system*

decimal digit or alphabetical letter can be represented by the pulse pattern recorded across one row. The presence or absence of a pulse is, of course, a binary method of recording data. As each character, either figure or letter, is portrayed by a variation of six elements, or bits, the code is referred to as a six-bit code. A range of 64 different characters can be represented.

Recording density

Each inch of tape contains 100 rows, so 100 characters are recorded to the inch. The fundamental unit of information handled within a computer system is known as a "word." In the Emidec 2400 system a word consists of 36 bits and this occupies six rows along the tape. The actual code used and the characters represented cover the 26 letters of the alphabet, the numerals 0 to 11 and some special control signs. A list of the characters and the equivalent six-bit code is shown in the table.

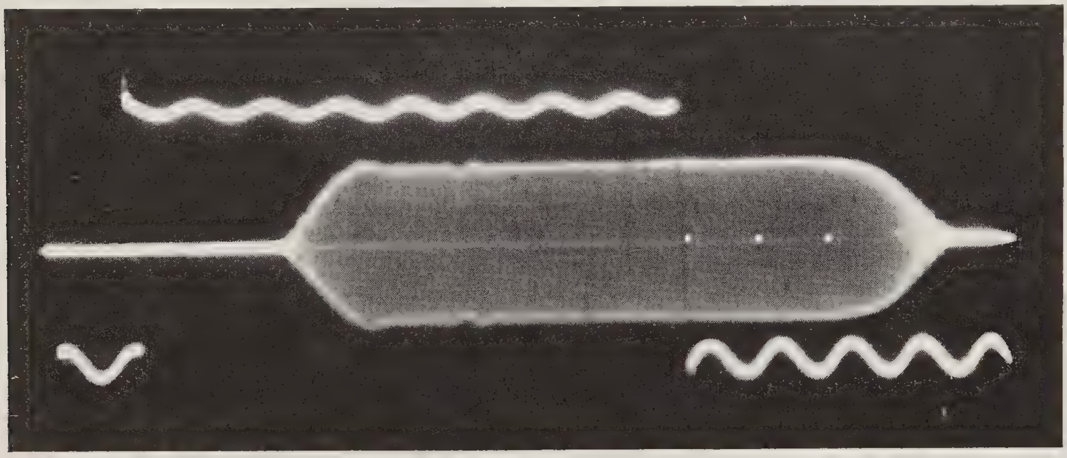
Numerical values in true binary form can also be handled and, in this case, a binary number 34 bits long can be recorded in one computer word. The remaining two bits available are used to specify the sign of the number, either positive or negative, and also the fact that it is in true binary form.

Checking procedures

Data entered on the four checking tracks of the tape depend upon the pulses recorded in the six information tracks. By the adoption of suitable checking codes it is possible to detect and correct single bit errors in the character recorded. When an error is detected either an automatic error correction sequence will be performed or the unit will be stopped. It is also possible by using the data recorded on one of the checking tracks to confirm that information has been correctly read from the tape before it is released to the computer. Many checks of this type are performed automatically whenever data are written on or read from the tape.

The magnetic tape is transported past the magnetic heads at a speed of 200 inches a second. At this speed 20,000 characters pass between the magnetic head and the tape in one second. Obviously, although the computer can accept or deliver data at this rate it will not require to do this continuously. Consequently, the tape has to be stopped and started intermittently to suit the needs of the computer. For this reason data are recorded in blocks on the tape, and unrecorded gaps are left between adjacent blocks. Individual gaps are long enough to allow the tape to be brought to rest from the operating speed of 200 inches a second and also to be started and regain full speed before the next block of data is reached. The length of the unrecorded gap required by this magnetic tape unit is 1·2 inches.

These unrecorded gaps must be made as small as possible to economize on tape. Also, when the computer requires information a long delay should not occur while the tape is accelerating up to the operating speed. To achieve these twin aims a high-performance, tape-winding mechanism is needed.



This cathode ray picture shows the performance of the Emidec 1*-inch tape deck. The wavy lines are the time base—each wave, from crest to crest, represents* 1 *millisecond* (0·001 *second*). *The central trace indicates the tape speed. The wide band when the tape is travelling at full speed and, at each end, relatively thin, uniform lines when the tape is stationary. When the start signal is given the time base trace moves from the bottom to the top of the picture and when the stop signal is given the trace reverts to the bottom of the picture again. It can be seen that from the time the start signal is given to the tape travelling at full speed, about* 3½ *milli-seconds elapse* (0·0035 *seconds*)

Performance

The Emidata high-speed tape unit for the Emidec 2400 computer can stop the tape from its full operational speed of 200 inches a second (11·4 miles per hour) or restart it from rest in less than 0·005 seconds (5 milliseconds). Tape can be reversed from full speed in one direction to full speed in the opposite direction in under 0·007 seconds (7 milliseconds). These times are measured from the moment the command is given to the time the tape is travelling at the correct speed.

In order to achieve this performance it has been necessary to devise an unusual form of tape transporting mechanism. On the Emidata tape unit—incidentally, these units are also referred to as tape decks—the transport mechanism comprises two tape reels situated on each side of the block of 24 magnetic heads. Between the magnetic heads and the reels are storage bins and the tape is fed into and out of the bins over special vacuum capstans known as bin capstans.

These capstans rotate continuously at a fixed speed. A number of holes are provided round the outer shell of each capstan, the interior of which is connected to a vacuum line. When the magnetic tape is stationary, it passes over the outer rotating shell, but is not in direct physical contact with it. When the tape is to be driven forward into the bin, air is drawn from the centre of the bin capstan to create a partial vacuum. The magnetic tape is sucked down into direct contact with the outer shell of the rotating capstan and propelled forward into the bin.

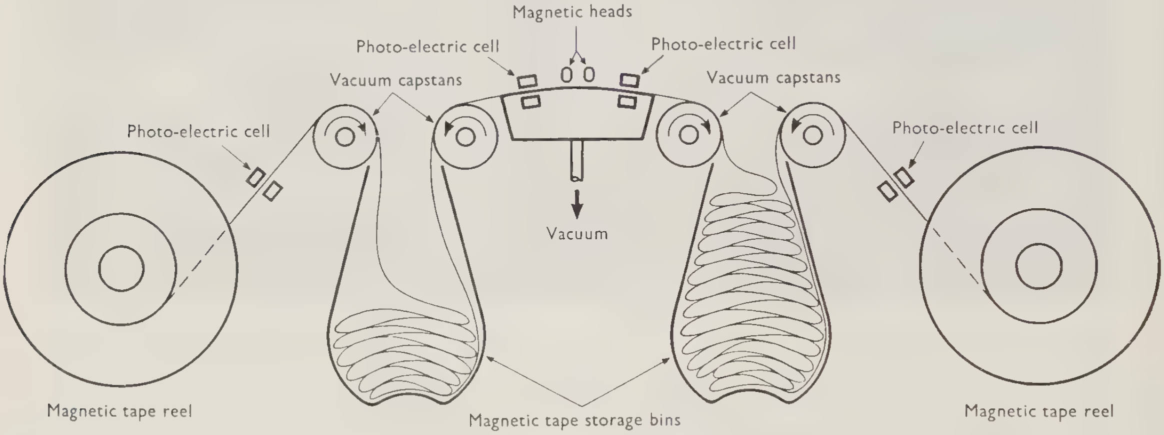
Each bin contains approximately 25 feet of tape. The length of tape present in each bin is sensed electrically and a control signal operates the motors driving the tape reels. As the bin is emptied, more tape is automatically fed in from the reel by the bin capstan, and conversely, as the bin is overfilled so tape is withdrawn and wound on to the reel. In addition, the binning capstans serve to maintain the tape in tension. Various safety trips are fitted that will stop the transport mechanism should the tape tension vary beyond certain prescribed values.

Similar capstans, to control the motion of tape past the magnetic heads, are mounted on each side of the bridge assembly. They rotate in opposite directions so that the tape is always pulled past the heads in the required direction by applying a vacuum to the appropriate capstan. To keep it perfectly flat and at the correct distance from the magnetic heads, the tape is passed over a perforated plate situated immediately beneath the magnetic heads. Air withdrawn from the underside of this plate causes the tape to conform precisely with the contour of this bridge plate on its way past the block of 24 reading and writing heads.

The magnetic tape is opaque, but for a distance of from 6 to 12 feet at each end the oxide coating is removed, leaving the transparent plastics base material. These clear portions are used as leaders when the tape is fitted in the machine. A number of photo-electric cells are sited adjacent to the transport mechanism to detect the change from opacity to transparency so that the leaders can never be inadvertently run off the reels.

The complete tape transport mechanism is contained in an airtight cabinet that is supplied with clean filtered air. Glass doors enclose the reel-driving mechanisms, magnetic reading heads and tape storage bins. Electrical interlocks are fitted to these doors and the unit cannot be operated unless the latter are closed and locked. The lower part of the cabinet houses all the electronics associated with the tape deck. Circuits and components are mounted on removable plug-in cards and transistors are used throughout the design. Servicing by replacement is possible and any circuits that develop faults can be unplugged and replaced by new ones.

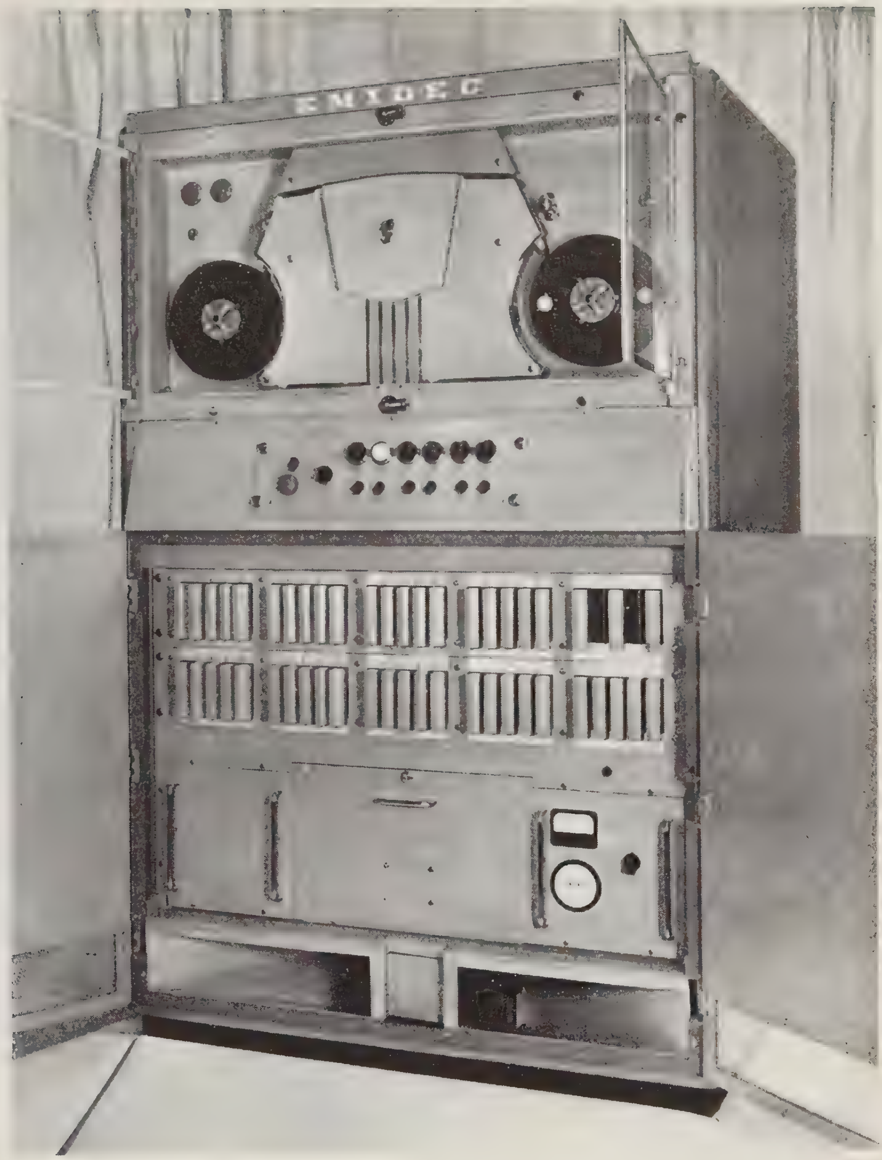
A reel of tape can be changed in 1½ to 2 minutes. Loading is simple. After the reels have been placed in position on the driving spigots the transparent leader is unwound and slipped in position straight across the tape deck under the magnetic heads to the empty reel on the other side. When the doors are closed and the unit is switched on, the tape will automatically be fed into the storage bins and, in addition, the beginning of the tape will be positioned automatically under the magnetic heads.



High-speed magnetic tape winding mechanism that enables tape to be accelerated or stopped with extreme rapidity. The vacuum capstans rotate continuously and the tape is driven, one way or the other, by extracting air from the centres of the appropriate capstans causing the tape to be sucked down into direct contact with them

On two numbered control knobs fitted to the tape deck panel, a two-figure decimal code number can be set that corresponds to the code number of the magnetic tape reel. This code number is recorded at the beginning of the tape; then, should the wrong reel be fitted, an interlock prevents the tape deck from being operated.

Tape reels now available for use with this particular magnetic tape deck are nine inches in diameter and contain 2,400 feet of tape. A reel

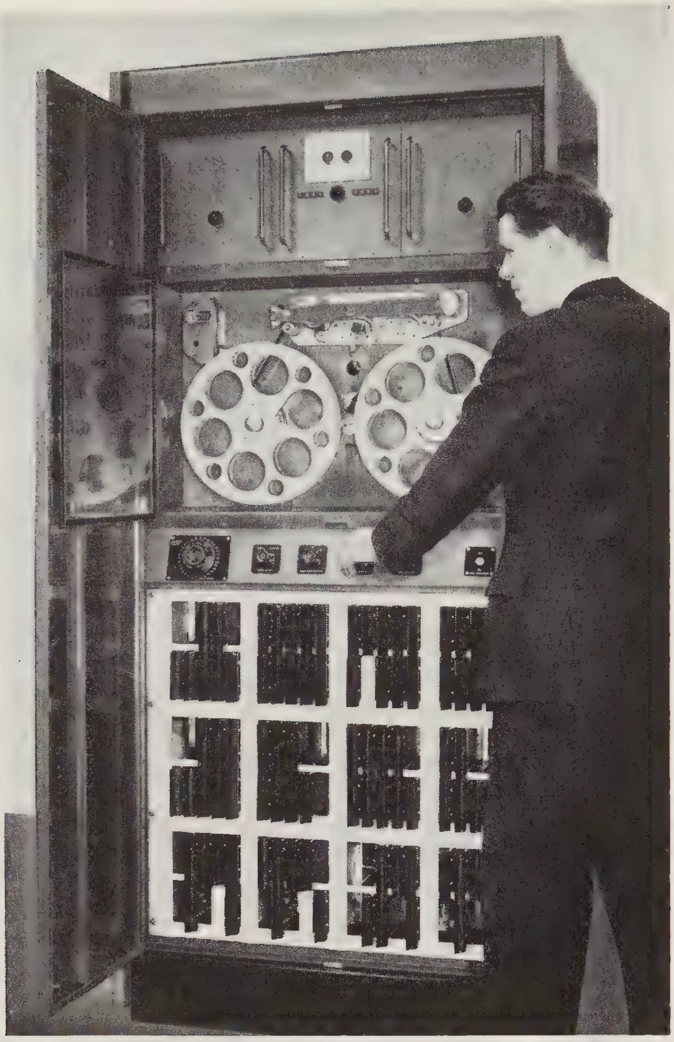


As many as 20 *magnetic tape decks of the type shown above can be fitted to an Emidec* 2400 *system. Reels,* 10½ *inches in diameter, containing* 3,500 *feet of tape,* 1 *inch wide, can be fitted to these units. Transistors are used throughout the design*

plus 2,400 feet of tape costs £25. In the near future reels 10½ inches in diameter will be available on which 3,500 feet of tape can be stored.

The Emidec 2400 computer can be equipped with up to 20 magnetic tape decks of the type described, although the first machine completed will be provided with eight. Each unit costs about £6,500. Included in this price is the cost of all the electronic circuits associated with the reading and writing operations.

Tapes can be interchanged between decks and a tape recorded on one unit can be fitted and read back on any of the other units. This latter feature is, of course, of great importance as the usefulness of magnetic tape would be severely restricted if the tape always had to be used on the same unit on which it was recorded.



Information obtained from nuclear experiments is recorded directly on magnetic tape by this unit. It was built for the United Kingdom Atomic Energy Authority. All data are recorded in digital form

At 200 inches a second it takes approximately 2½ minutes to run from one end of a 2,400-foot reel of tape to the other. Some of the factors that have to be considered when recording commercial data on tape have already been discussed in the article "Filing business data on magnetic tape."*

As a business document then, magnetic tape possesses many advantages over the more conventional forms of documentation, especially where high-speed electronic data processing machines are used. It is also likely that magnetic tape will be employed more extensively in the near future by science as well as industry. An example of such an application is the data recording and analysing system built for the United Kingdom Atomic Energy Authority. Nuclear experiments, it need hardly be said, are costly. Therefore, it is desirable that as much data be obtained from each experiment as is possible. Often millions of separate measurements need to be made. A magnetic tape recording system has been developed to cope with this work. The system consists of several magnetic tape recording units and a high-speed data analyser. Tape, one inch in width, is stored on special large-capacity reels containing 7,200

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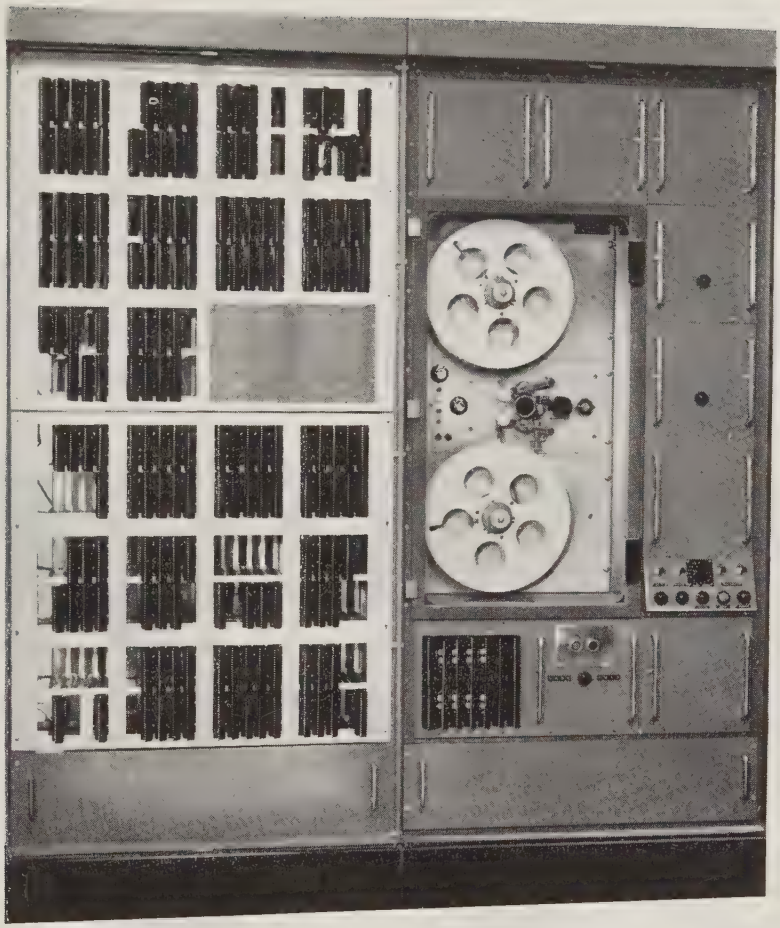
*Page 113, *Data Processing*, April-June, 1959.



Experimental data recorded on magnetic tape are analysed by this unit. The tape is played back at a speed of 100 *inches a second. Data read from the tape are sorted into order and retained in an information store*

feet. The tape is moved past the magnetic recording head at a speed of one inch a second. Consequently, each spool contains sufficient tape for 24 hours' continuous recording.

Various physical factors of the experiment are measured by instruments; the data obtained are converted into digital binary coded form and recorded on 16 channels of the magnetic tape.

At the end of the experiment the tape is removed from the recording unit for the data to be analysed. Tape is played back through the analyser at 100 inches a second. Data are sorted automatically into order and retained in an information store. When the data are required they can then be obtained in the correct sequence from the store. If necessary, the data can be transferred on to punched paper tape ready for use in other data processing procedures—for example, to be fed to a conventional digital computer. Alternatively, the data can be printed on paper in tabular or graphical form.

Obviously, a data recording system of this type could be used equally well for obtaining information concerning the day-to-day operation of a continuous-process plant or even a factory engaged on mass-production work. It is the adaptability of magnetic tape and the universal nature of its application that is rapidly making it one of the more important documents used in business and industry.

Accurate copy typing at 100 words a minute

Obviously, mechanical repetitive work such as copy typing can be carried out more accurately by a fully automatic machine than by a human operator. Not only are mistakes avoided but also average typing speeds are higher. If the machine is equipped to handle continuous stationery and the job is lengthy, the machine operator is free to perform other tasks. These are some of the immediate advantages of using, for copy typing, fully automatic electric typewriters such as Flexowriters. In addition, because the original information is recorded on punched paper tape, it is possible to feed it directly to a computer. Thus not only can a Flexowriter be used by itself, it can also be integrated relatively easily in any comprehensive data processing system

Automatic copy typing. Data being read from a punched paper tape and printed on a document at 100 words a minute

Where the same information has to be typed repeatedly on a number of different documents, an automatic method naturally offers many advantages. Not the least are the high speed at which the information is reproduced and the accuracy resulting from the elimination of manual transcription. Nowadays, an automatic, power-operated typewriter called the "Flexowriter" is being used increasingly for work of this nature. Of American design, it is marketed in Great Britain by Bulmers (Calculators), Ltd., together with a series of other automatic machines that have been developed from it.

Basically, the Flexowriter is an electric typewriter fitted with an automatic paper tape punch and an automatic tape reader. As information is typed on the keyboard of the machine so a punched paper tape is produced in addition to the normal typed document. Information is punched in the tape in a special coded form. To reproduce this on another document, the perforated tape is fed through the reading unit and the typewriter automatically types the data at a speed of 572 characters (100 words) a minute.

From this brief description of the machine, it is obvious that instructions to control the operation of the machine must be included in the tape in addition to the data to be typed. These instructions are recorded by pressing special control keys provided on the keyboard. For example, to return the carriage to the beginning of the next line, a carriage return key is provided and every time it is depressed the appropriate group of holes is punched in the paper tape. Consequently, when the tape is read, the carriage is returned at the required moment. A number of other instructions, sometimes referred to as programme instructions, can be encoded in the tape in this way. These instructions control tabulation, the selection of upper and lower case characters and the use of the tape punch.

When these programme instructions are included with the data to be printed, the typewriter is controlled in a manner similar to manual operation.

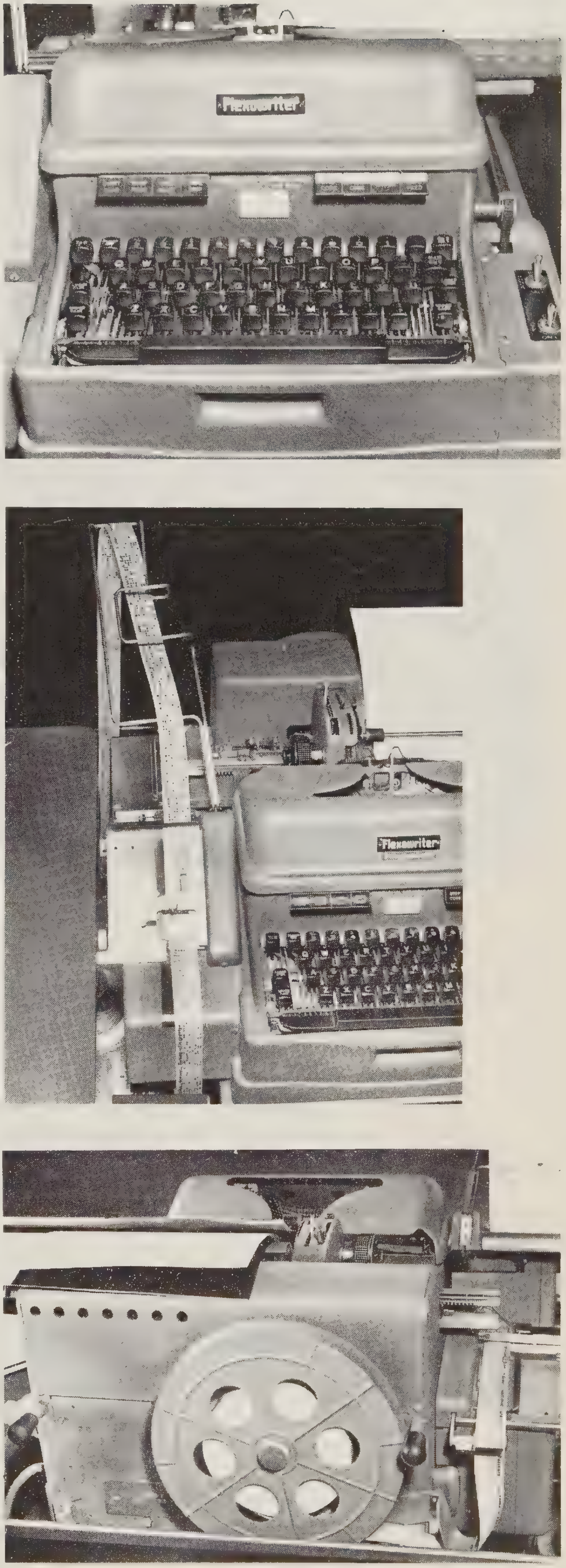
Flexowriters can also be fitted with an attachment which can read a special form of edge-punched card. Down one edge of these cards a series of holes are punched, which are identical with the holes punched in the tape.

Permanent data

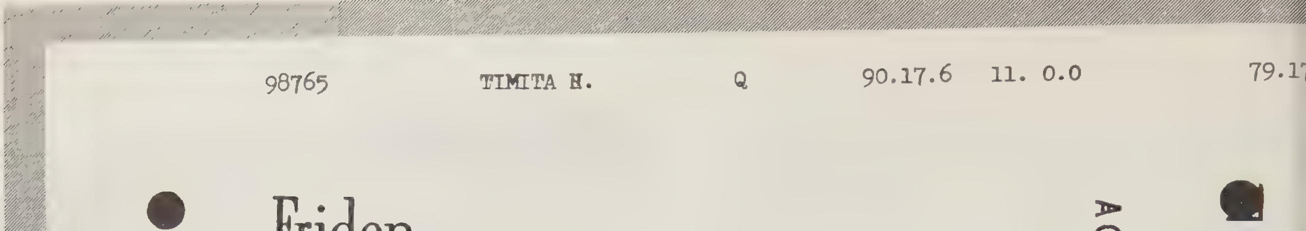
Cards can be joined to one another to form a continuous strip. Permanent data are generally recorded on these cards. On the plain portion of the card the data are reproduced in writing. In this way, the cards can be deciphered both visually and mechanically.

Another feature of the Flexowriter is that a duplicate tape can be made simultaneously if the punch unit is switched on while a tape is being read. A typed document can also be produced at the same time, if required. Flexowriters are equipped to read and punch either 5-channel or 8-channel paper tape.

In commerce, there are obviously many jobs such machines can carry out. Typical of these is a staff payroll application. At the London office of a major oil company, accounts are kept of the salaries of all staff employed overseas. Salaries are paid monthly, either in sterling or in dollars, and the amount due to each employee together with details of deductions, has to be entered on a file of record cards. One record card is kept for each employee. In addition,



Basically, a Flexowriter is an electric typewriter fitted with a paper tape punch and a paper tape reader. Top right is the keyboard, in the middle the tape reader and on the right the tape spool and the tape punch



98765 TIMITA H. Q 90.17.6 11. 0.0 79.1

Friden

EDGE PUNCHED CARD

Friden Calculating Machine Co., Inc.

San Leandro, Calif.

A06404

Fride

salary advice notes have to be prepared and a register of salaries maintained. Payment lists also are printed for the bank, so that the appropriate amounts will be credited to the correct accounts. This work requires the basic data to be reproduced a considerable number of times on different documents.

A machine called the Flexowriter Programatic FPC-8 (double-case) is used which is equipped for reading edge-punched cards as well as punched paper tape. The machine operates with 8-channel tape. The word "Programatic," of course, refers to the automatic performance by the machine of a set sequence of operations—the programme instructions read from the tape. The reference "double case" indicates, naturally, that the machine can reproduce both capitals and small characters.

All permanent information about an employee is punched in an edge-punched card. These data are also typed on the plain portion of the card. Information recorded are: Name, staff number, gross monthly increment of salary, tax and standard deductions. When the documents for the next monthly payment are being prepared, the first step is to update the employee's record card. The main portion of this card contains 15 columns. All the data for one month's salary are contained on one line of the card. Consequently, as the cards remain in use for one year, a completed card contains twelve entries.

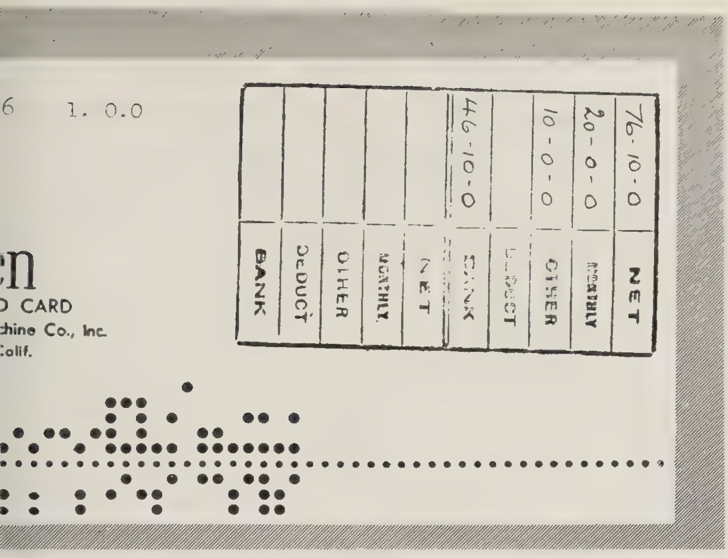
The Flexowriter operator winds the record card over the platen of the machine and positions it on the line for the next entry. A blank tape is fed into the punch, which is then switched on. In addition, the edge-punched card for the employee is positioned in the reader. Everything is now ready for an entry to be made.

The date is entered in the first column of the card and, as this is a variable, it is typed by the operator. Then the operator depresses the "start read" key and data for the next seven columns are read automatically from the edge-punched card and typed on the record card. Programme instructions are included among the data recorded on the edge-punched card and the carriage moves automatically to each column in turn.

When the machine reaches the column headed "monthly withholding" it will stop, as this is the next variable which has to be typed by the operator. Entries in the three remaining columns also vary from month to month and have to be entered manually. Payment to be made into the employee's bank account is recorded in the final column.

As the tape punch is switched on throughout this operation, all the data, both permanent and variable, are faithfully recorded on the 8-channel tape. Record cards for all the other employees are updated in the same way. Consequently, at the end of this procedure all the data for the monthly payroll will be contained on the tape. Information from the payroll tape is now reproduced entirely automatically on all the other documents required.

Compilation of the monthly salary register is the next job. The payroll tape is fed into the reader of the Flexowriter and all the information on the tape is typed automatically on the salary register. Lines typed are, of course, identical with the individual entries made on the employees' record cards.



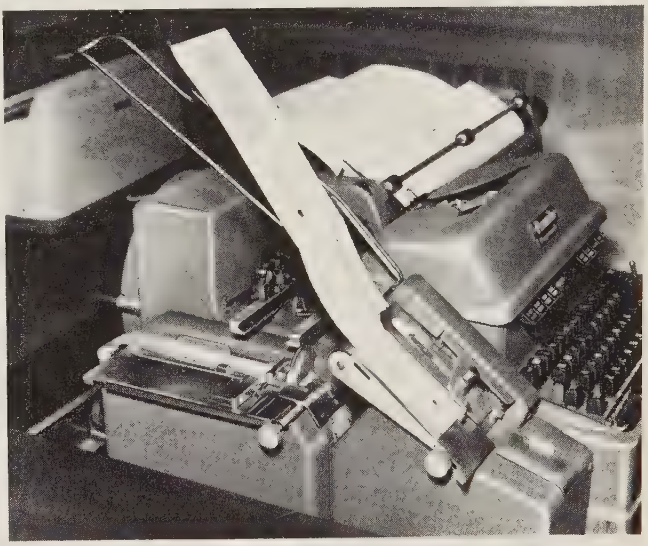
6 1. 0.0

en
D CARD
chine Co., Inc.
Calif.

NET	MONTHLY	OTHER	DEDUCT	BANK	NET	MONTHLY	OTHER	DEDUCT	BANK
76-10-0	20-0-0	10-0-0		46-10-0					

Left) Permanent data about an employee are recorded in edge-punched cards as a series of holes. The same data are also typed on the plain portions of the cards

Either punched tape or edge-punched cards can pass through the automatic reader

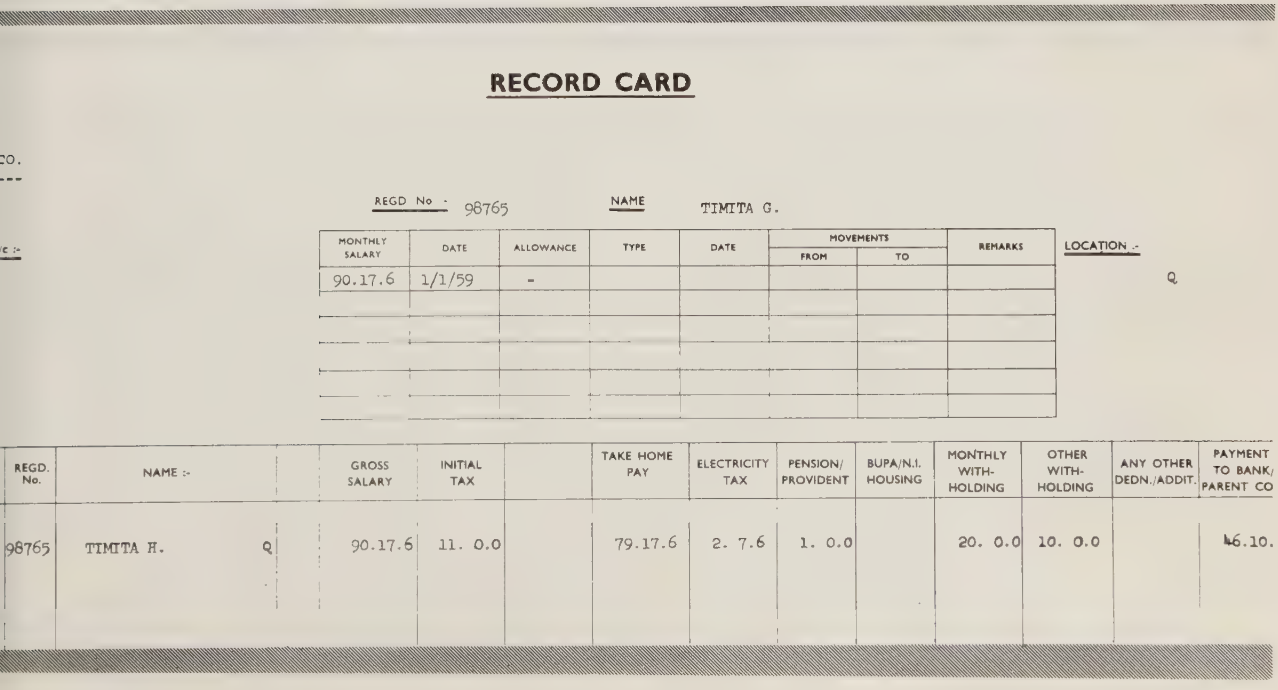


After this, the information on the tape is again reproduced in its entirety, but with a greater space allowed between the lines. This document is cut into strips, each strip containing one typed line. These are the salary advice notes sent to the employees each month.

A third document produced automatically is the list of payments for the company's bank. This list informs the bank of the amount to be credited to the account of each member of the staff. In this case only the registered number (staff number) and net pay of each employee are required.

To select these data from the bulk of the payroll information, use is made of an automatic facility provided on the Flexowriter—that of controlling the operation of the tape punch. One of the control switches on the keyboard is

An employee's salary record card



RECORD CARD

CO.

C :-

REGD No - 98765 NAME TIMITA G.

LOCATION - Q

MONTHLY SALARY	DATE	ALLOWANCE	TYPE	DATE	MOVEMENTS		REMARKS
					FROM	TO	
90.17.6	1/1/59	-					

REGD. No.	NAME :-		GROSS SALARY	INITIAL TAX		TAKE HOME PAY	ELECTRICITY TAX	PENSION/ PROVIDENT	BUPA/N.I. HOUSING	MONTHLY WITH-HOLDING	OTHER WITH-HOLDING	ANY OTHER DEDN./ADDIT.	PAYMENT TO BANK/ PARENT CO
98765	TIMITA H. Q		90.17.6	11. 0.0		79.17.6	2. 7.6	1. 0.0		20. 0.0	10. 0.0		46.10.

labelled "All—Select". When this switch is in the "All" position, all the data obtained from a punched tape proceeding through the reader are reproduced on a second tape. With the switch in the "Select" position, however, only selected data read from the first tape will be reproduced in the second tape.

Reproducing selected data

Selected data are identified by two special code instructions punched in the tape. One instruction is placed immediately before the data to be reproduced and the other immediately after. The first code switches the tape punch on and the second switches the punch off.

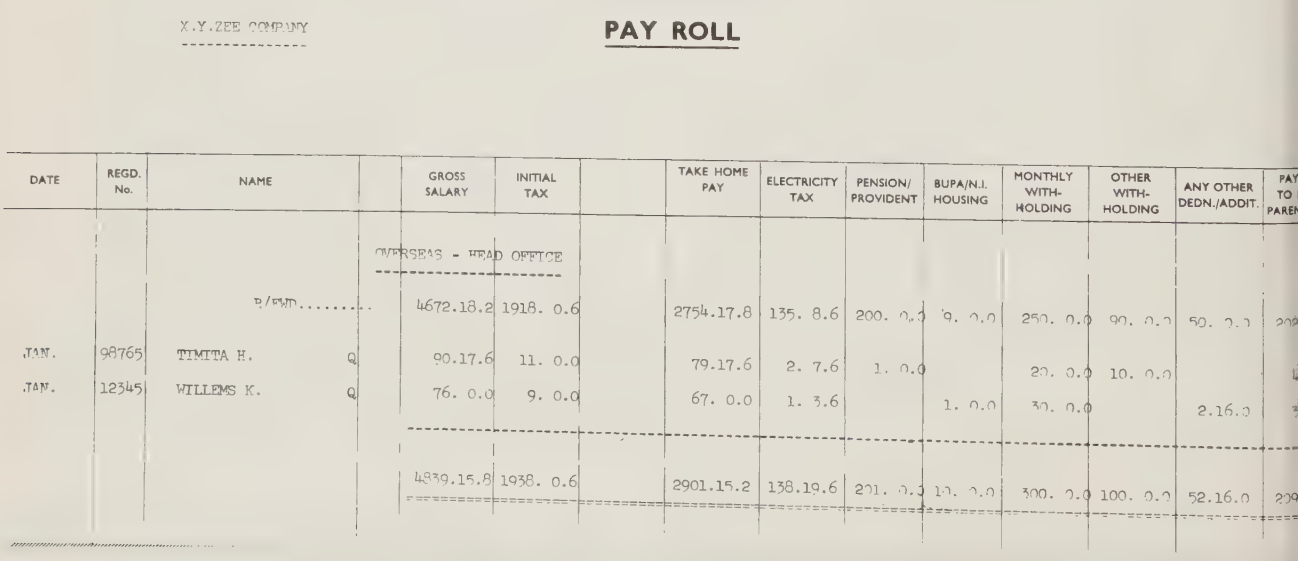
Before the salary register is automatically typed, the switch is set to "Select." Of all the data read from the tape only the employeе's registration number and net monthly pay are accompanied by the special code instructions; consequently these are the only data reproduced by the punch in the second tape.

The list of payments for the bank is typed automatically from the second tape. After this operation, the prepared typed list is passed through the Flexowriter a second time, when the name of the account and the bank into which payment is to be made are typed alongside each entry. This information is read automatically from a permanent file of edge-punched cards.

It has been stated already that data must be accompanied by programme instructions. In the case of permanent data recorded on edge-punched cards, the same programme instructions have to be included on each individual card in the same sequence. As there is a large number of records, it would have been tedious when the edge-punched cards were being prepared, to type the same programme instructions repeatedly, together with the appropriate permanent data. Consequently a master programme was compiled and punched into a tape. This tape was fed through the reader of the Flexowriter and a blank card fed through the punch. As the machine performed the instructions read from the tape, they were reproduced in the card. Every time the machine halted, the appropriate permanent data with regard to the employee were typed and this was recorded in the edge-punched card at the same time. The next programme instructions were read from the tape and then further information about the employee entered on the card. By proceeding in this way, permanent data, together with the appropriate programme instructions, were arranged in the correct sequence on all the edge-punched cards.

Work load

In five working days, one operator using a Flexowriter Programatic prepares the salary register for 600 employees, both sterling and dollar currencies are handled, and produces all the other related documents. For the remainder of the month the Flexowriter is used on other work associated with salaries. For example, about 20 special lists are produced that give full details of staff national insurance contributions, pension contributions, repayment of house loans and so on. In addition, a large number of standard letters that have to be despatched monthly to associated companies giving details

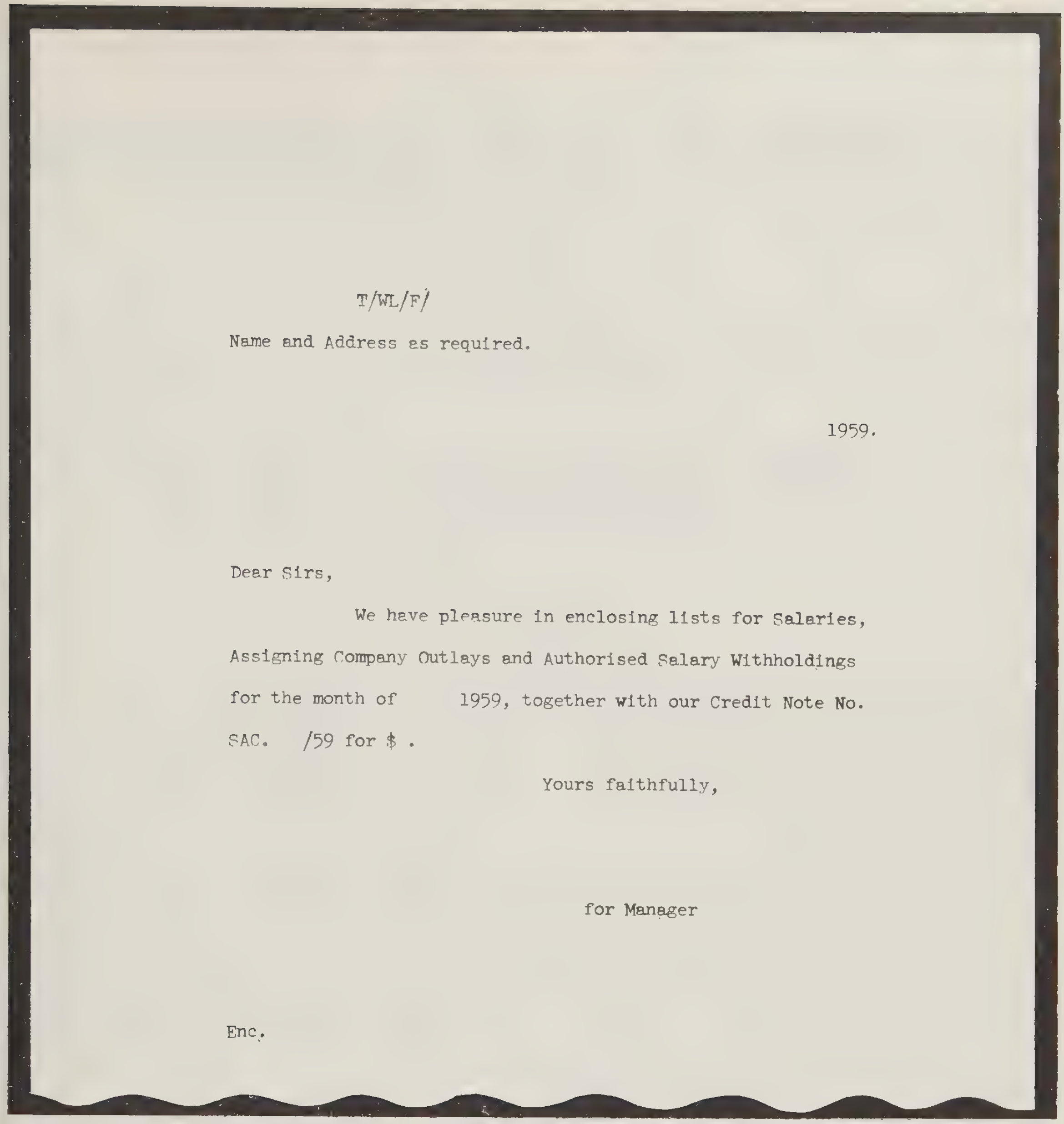


The pay roll, or salary register, is typed automatically from data recorded on 8-channel punched paper tape

X.Y.ZEE COMPANY

PAY ROLL

DATE	REGD. No.	NAME		GROSS SALARY	INITIAL TAX		TAKE HOME PAY	ELECTRICITY TAX	PENSION/ PROVIDENT	BUPA/N.I. HOUSING	MONTHLY WITH-HOLDING	OTHER WITH-HOLDING	ANY OTHER DEDN./ADDIT.	PAY TO PAREN
			OVERSEAS - HEAD OFFICE											
		B/FWD.........		4672.18.2	1918. 0.6		2754.17.8	135. 8.6	200. 0.0	9. 0.0	250. 0.0	90. 0.0	50. 0.0	[illegible]
JAN.	98765	TIMITA H.	Q	90.17.6	11. 0.0		79.17.6	2. 7.6	1. 0.0		20. 0.0	10. 0.0		[illegible]
JAN.	12345	WILLEMS K.	Q	76. 0.0	9. 0.0		67. 0.0	1. 3.6		1. 0.0	30. 0.0		2.16.0	[illegible]
				4839.15.8	1938. 0.6		2901.15.2	138.19.6	201. 0.0	10. 0.0	300. 0.0	100. 0.0	52.16.0	[illegible]



T/WL/F/

Name and Address as required.

1959.

Dear Sirs,

We have pleasure in enclosing lists for Salaries, Assigning Company Outlays and Authorised Salary Withholdings for the month of 1959, together with our Credit Note No. SAC. /59 for $.

Yours faithfully,

for Manager

Enc.

Standard business letters are also typed automatically by the Flexowriter. Only information such as name and address, month, credit note number and total amount have to be entered manually

of salaries paid, are typed automatically by this machine. Naturally, the standard letter is encoded on tape, only leaving the name and address and a few items to be entered manually.

From the experience gained, the company considers that Flexowriters can be used for a large number of other routine office jobs. One that is being investigated is that of stock re-ordering. In this work, quantities of many standard consumable items are re-ordered at regular intervals and it is proposed that all the typewritten documents needed for this purpose be produced automatically on a Flexowriter.

To-day, comparatively few companies make use of such automatic writing equipment, largely because the price of these machines is high compared with that of a standard typewriter and also, probably, because many clerical routines are poorly planned.

However, where systems can be adapted and documents redesigned to suit the capabilities of an automatic typewriter, the consistent and accurate reproduction of data at the rate of 100 words a minute will soon provide considerable and worthwhile financial savings by reducing considerably the amount of manual copy typing.

350 invoices a day and statistics

A case study that reveals how a manufacturing chemist uses a small punched card installation to relieve the sales staff of time-wasting clerical work, produce invoices and despatch notes, keep in continuous touch with sales trends and have immediate information on the effects of any special sales campaign that is undertaken

NEARLY all the information management could wish to know about the current pattern of sales is on the invoices prepared each day, if only it can be extracted. Unhappily, the task of selecting, sorting and collating the original data is too difficult, or so it seems.

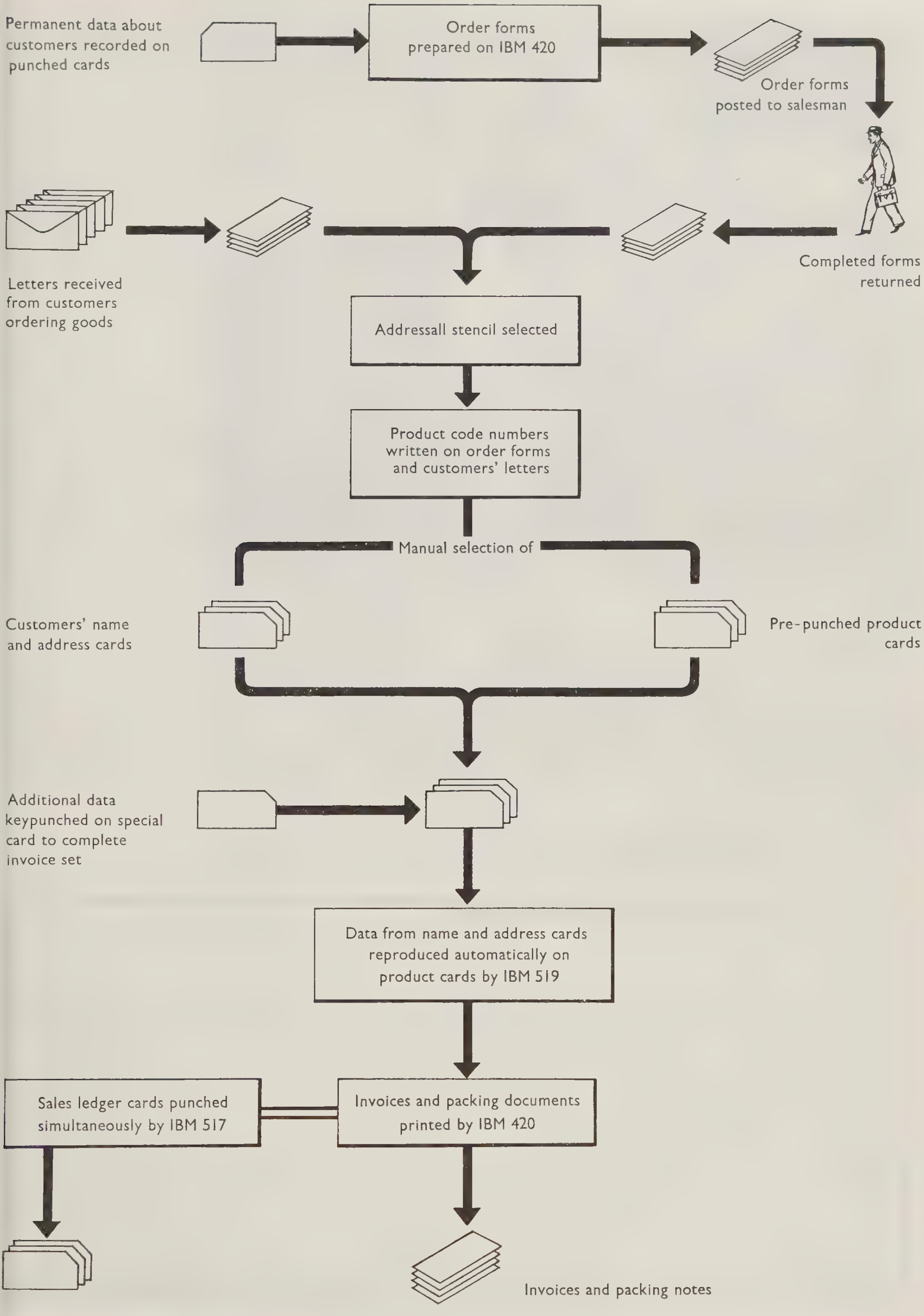
One solution is to record all sales data on punched cards. But here again, unless the system has been devised with care and knowledge, management may be deterred from requesting unusual statistics because they know that the cost of compiling the figures would not be warranted. Also they know that any request for facts and figures, other than those normally produced, is likely to bog down the "machine." Thus the established system becomes sacrosanct and administrative flexibility is sacrificed, supposedly for the sake of the data processing equipment. This need not be so. It is possible to create a punched card data processing system which will produce all the invoice and despatch documents needed each day together with sales statistics and yet, at the same time, be capable of supplying special statistics whenever these are required by management.

Vick International Limited, pharmaceutical manufacturers, operate a punched card data processing system which has been developed so that the drudgery of routine clerical work has been removed from the sales staff, leaving them free to concentrate exclusively on their primary task—selling. The entire work of preparing order forms, printing invoices and producing all necessary statistics is performed by ten operators using a small IBM installation, comprising three key punches, two IBM 420 tabulators, an IBM 083 sorter, an IBM 519 reproducing punch and an IBM 517 summary punch.

Twelve travelling salesmen are employed by the company. Normally every regular customer is visited once in twelve weeks. Before starting on a weekly round each salesman is supplied with a set of printed order forms, one for each customer. These are prepared by a separate section of the data processing group and a special library of punched cards is maintained for this purpose.

Customer records

Information concerning a customer is recorded on a set of four or more punched cards. These show the customer's name and address, miscellaneous information, buying record and display record. On the miscellaneous card is entered background information for the salesman's use. Such information would be the buyer's name in a large store, early closing day and so on. Information on this card is usually recorded at the request of the salesman so that he has an *aide-mémoire*. Obviously, from a sales point of view these data are valuable since they help the salesman to maintain continuity; for example, if the customer has a favourite topic or hobby, this, too, can be recorded on the card. On the buying record card, all the products ordered by the customer over the last two years

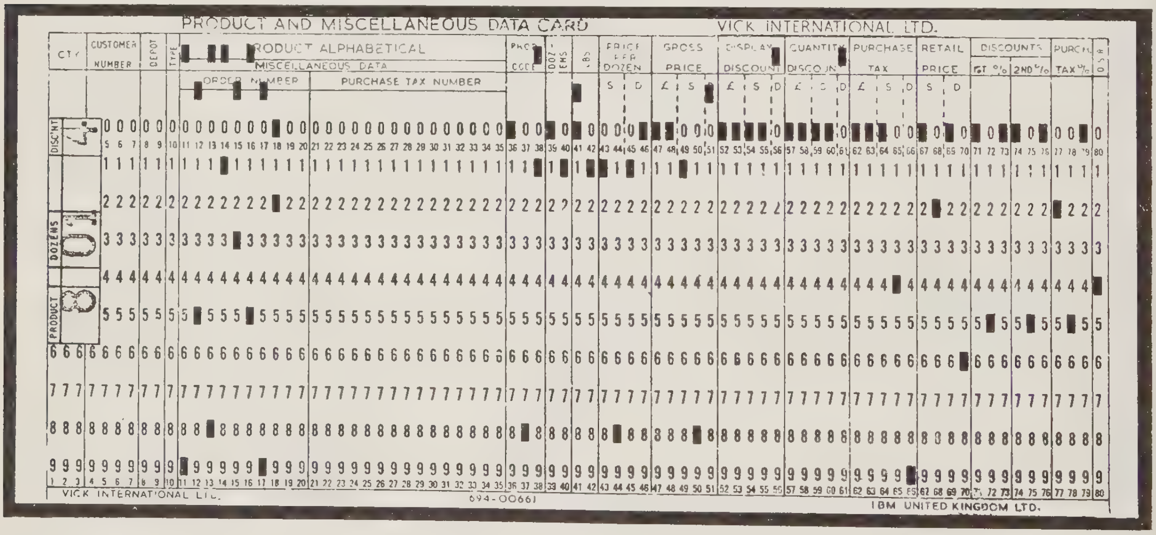

Permanent data about customers recorded on punched cards
Order forms prepared on IBM 420
Order forms posted to salesman
Letters received from customers ordering goods
Completed forms returned
Addressall stencil selected
Product code numbers written on order forms and customers' letters
Manual selection of
Customers' name and address cards
Pre-punched product cards
Additional data keypunched on special card to complete invoice set
Data from name and address cards reproduced automatically on product cards by IBM 519
Sales ledger cards punched simultaneously by IBM 517
Invoices and packing documents printed by IBM 420
Invoices and packing notes

Operators selecting pre-punched cards. On the left is the file of product cards and on the right, in the background, is the file containing customers' cards

are listed and, in a similar fashion, information of the special counter displays provided by Vick International and used by the customer to boost sales is recorded on the display card.

All these cards, arranged in individual sets for each customer, are stored in the special library of punched cards in the sequence in which the salesman makes his calls during the week. When a weekly set of sales order forms are to be prepared, the appropriate groups of punched cards are withdrawn from the library and passed through an IBM 420 tabulator. Blank order forms, joined together as continuous stationery, are fed through the tabulator and the

A pre-punched product card. Data obtained from customers' cards will be punched automatically in the first ten columns. (Column numbers are indicated in the line at the foot of the card)



information, as read from each set of cards, is printed, in sequence, on these forms.

Each day the salesman, armed with appropriate sets of forms, goes out to pay calls and obtain new orders. Because all the pertinent permanent information has been printed on the forms already, only the quantities of goods ordered by the customer need be written down by the salesman. A special panel on the right-hand side of the form is provided for this purpose.

At the end of each day the completed order forms are returned, by post, to the head office. This procedure avoids the salesman having to spend a considerable time each evening on purely clerical work.

New orders, whether taken by the salesmen or received by post direct from customers, obviously alter the buying records. Consequently, these data have to be updated. This is done by keypunching the new information into the buying record card manually. This occurs at a later stage after the invoices have been produced. When the buying and display record cards have been updated they are filed in the library ready for the next time this particular group of order forms has to be prepared.

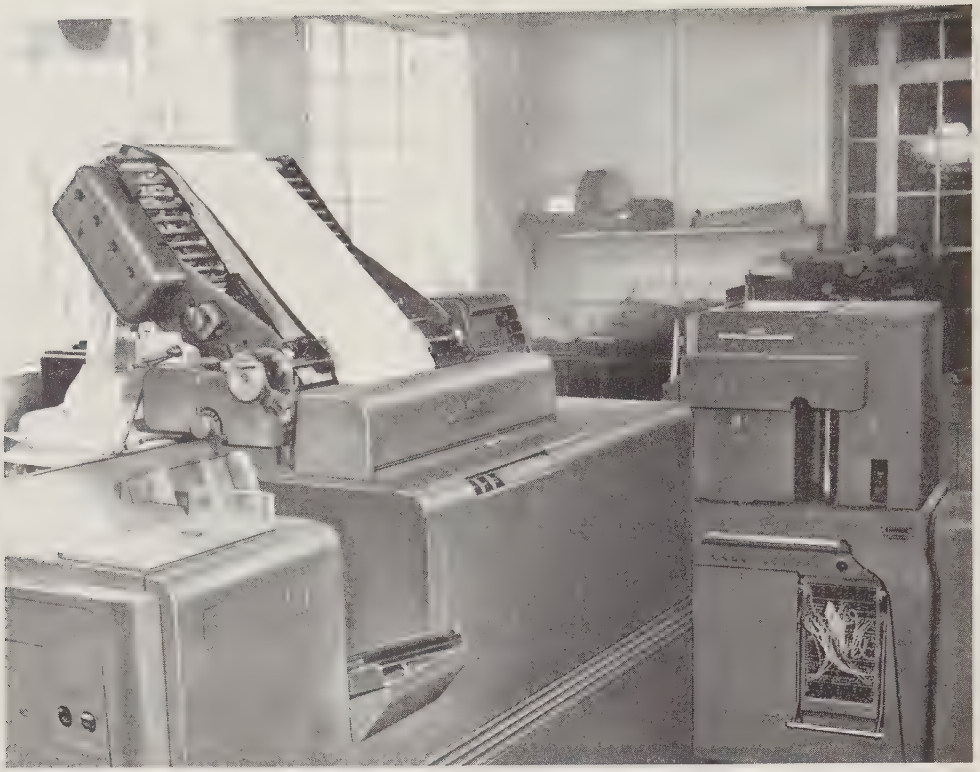
Orders received at the head office, whether from salesmen or customers, are passed to the data processing section. They go, first, to a girl who selects the appropriate Addressall stencils for the parcel labels. A file of 15,000 stencils is held in this section and a stencil is clipped to each order document, which is then handed to a coding clerk.

Each of the 40 or more products manufactured by Vick International has a code number. The size of pack in which the product is supplied and the discount rate allowed are also indicated by the code number. For instance, "12C" identifies a pack containing one dozen Vapomist.

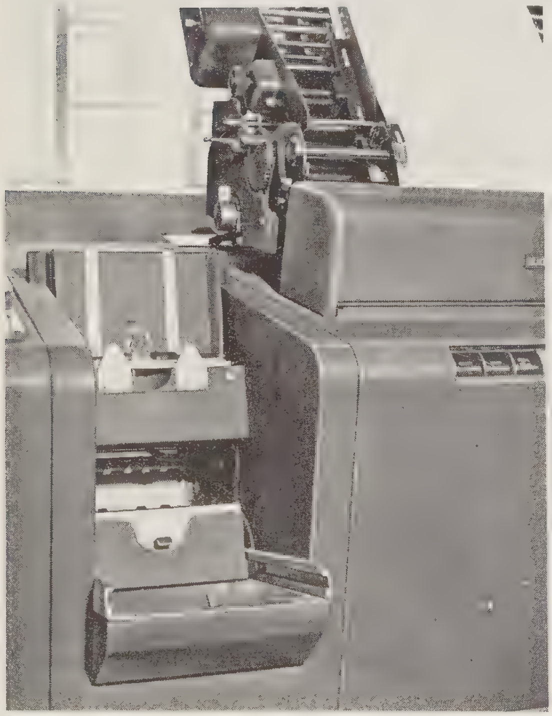
Additional information needed to complete an invoice is punched into a miscellaneous data card

The coding clerk writes the appropriate code number for each item or group of items on the order form or customer's letter, as the case may be. Customers' letters proceed through the system in exactly the same way as a salesman's order forms. After coding, the order documents are sent to a third clerk, who selects pre-punched cards containing the data necessary for compiling the invoices.

Two files of pre-punched cards are maintained. One contains information concerning customers and the other details of products. Data



An IBM 420 accounting machine fitted with a continuous stationery feed mechanism. A summary punch (seen on the right) is connected to it. Below is shown the punched-card magazine of the machine.



included on the first set of cards are the classification of the customer (chemist, wholesaler or hospital) and the nearest supply depot.

Among the information recorded on a pre-punched product card is: description of product, product code, quantity in pack, weight of pack, price per dozen, gross price, discounts allowed, purchase tax, retail price and the rate of purchase tax. Actually these cards are designed to serve two purposes. They are also used as miscellaneous data cards and the columns headed "order number" and "purchase tax number" refer to the data that are punched in these columns when used in this context. Otherwise alphabetical letters which describe the product are punched in these positions.

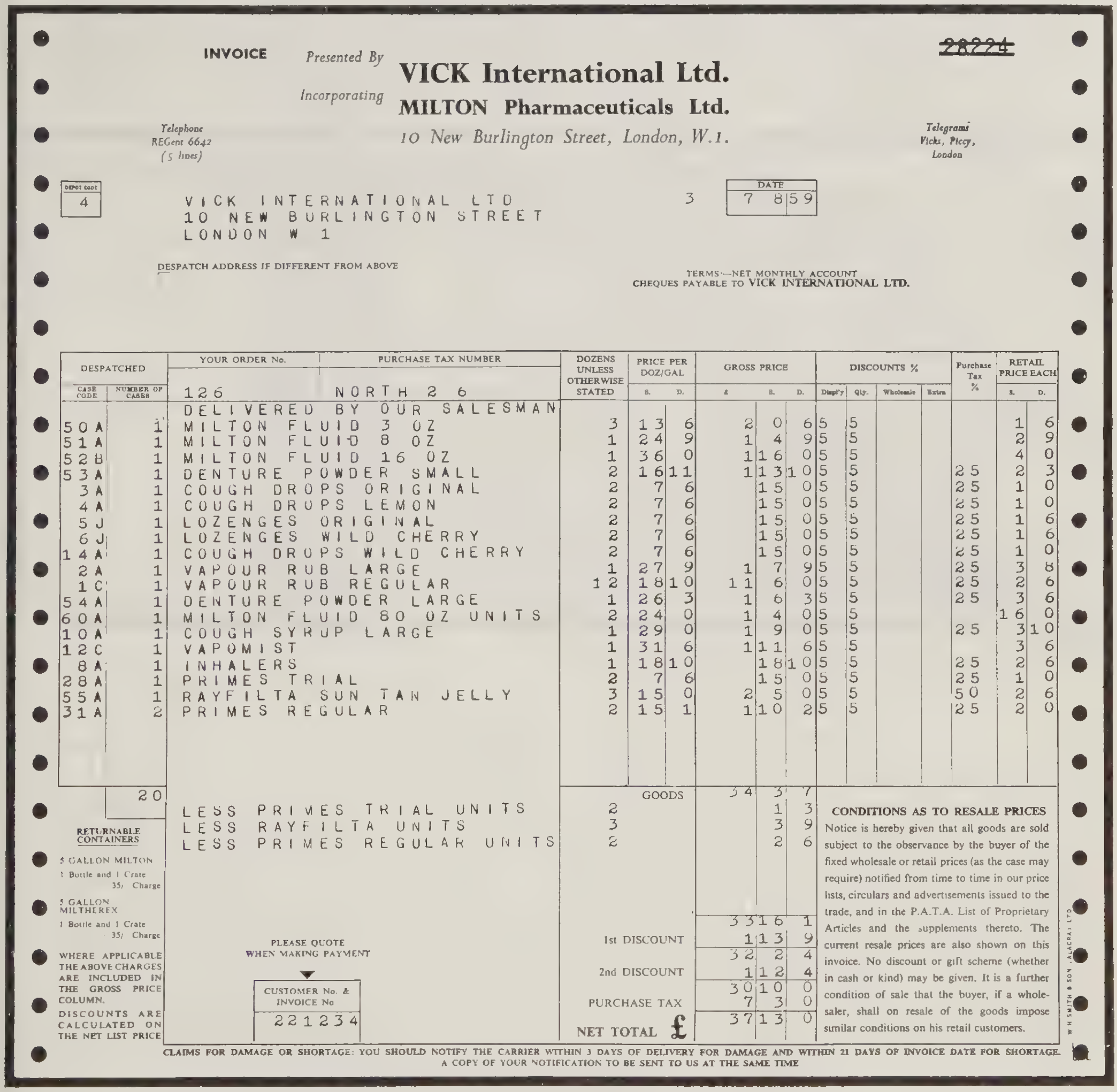
Hence, when the third clerk receives the order documents from the coding clerk she takes each one in turn and selects the appropriate set of name and address cards from the first file—there is one card for each line printed in the address. After this, she goes to the second file and pulls one pre-punched product card corresponding to each code number written on the order form.

Products cards are placed behind the name and address cards to make a complete invoice set.

Occasionally additional data such as purchase tax certificate numbers are required on invoices, notably where goods are supplied to wholesalers. Miscellaneous information is not available in pre-punched form, so it has to be entered on a special card by hand. An IBM 026 keypunch is used for this. The resultant punched card is placed in the invoice set between the address cards and the product cards. Only one operator is employed on keypunching, as less than five per cent of the orders require the additional card. Now all the order documents, accompanied by the sets of punched cards, are handed to a checking clerk. Then the cards are passed on to the IBM 519 reproducing punch.

Packs of cards, arranged in invoice sets, are placed in the input hopper of the punch. The first cards in any set are the name and address cards. These pass through the machine first. The customer's number, classification, county and depot are read from the address cards and retained in a special register in the machine. These data are then reproduced automatically in the first ten columns of all product cards that follow. This operation is continued until the name and address cards of the next invoice

An invoice printed from data recorded on a set of pre-punched cards. The various totals are compiled automatically



~~28224~~

INVOICE *Presented By* **VICK International Ltd.**
Incorporating **MILTON Pharmaceuticals Ltd.**
10 New Burlington Street, London, W.1.

Telephone
REGent 6642
(5 lines)

Telegrams
Vicks, Piccy,
London

DEPOT CODE
4

VICK INTERNATIONAL LTD
10 NEW BURLINGTON STREET
LONDON W 1

3

DATE
7 8 59

DESPATCH ADDRESS IF DIFFERENT FROM ABOVE

TERMS—NET MONTHLY ACCOUNT
CHEQUES PAYABLE TO VICK INTERNATIONAL LTD.

DESPATCHED		YOUR ORDER No. · PURCHASE TAX NUMBER	DOZENS UNLESS OTHERWISE STATED	PRICE PER DOZ/GAL		GROSS PRICE			DISCOUNTS %				Purchase Tax %	RETAIL PRICE EACH	
CASE CODE	NUMBER OF CASES	126 NORTH 2 6		S.	D.	£	S.	D.	Displ'y	Qty.	Wholesale	Extra		S.	D.
		DELIVERED BY OUR SALESMAN													
50 A	1	MILTON FLUID 3 OZ	3	13	6	2	0	6	5	5				1	6
51 A	1	MILTON FLUID 8 OZ	1	24	9	1	4	9	5	5				2	9
52 B	1	MILTON FLUID 16 OZ	1	36	0	1	16	0	5	5				4	0
53 A	1	DENTURE POWDER SMALL	2	16	11	1	13	10	5	5			25	2	3
3 A	1	COUGH DROPS ORIGINAL	2	7	6		15	0	5	5			25	1	0
4 A	1	COUGH DROPS LEMON	2	7	6		15	0	5	5			25	1	0
5 J	1	LOZENGES ORIGINAL	2	7	6		15	0	5	5			25	1	6
6 J	1	LOZENGES WILD CHERRY	2	7	6		15	0	5	5			25	1	6
14 A	1	COUGH DROPS WILD CHERRY	2	7	6		15	0	5	5			25	1	0
2 A	1	VAPOUR RUB LARGE	1	27	9	1	7	9	5	5			25	3	8
1 C	1	VAPOUR RUB REGULAR	12	18	10	11	6	0	5	5			25	2	6
54 A	1	DENTURE POWDER LARGE	1	26	3	1	6	3	5	5			25	3	6
60 A	1	MILTON FLUID 80 OZ UNITS	2	24	0	1	4	0	5	5				16	0
10 A	1	COUGH SYRUP LARGE	1	29	0	1	9	0	5	5			25	3	10
12 C	1	VAPOMIST	1	31	6	1	11	6	5	5				3	6
8 A	1	INHALERS	1	18	10		18	10	5	5			25	2	6
28 A	1	PRIMES TRIAL	2	7	6		15	0	5	5			25	1	0
55 A	1	RAYFILTA SUN TAN JELLY	3	15	0	2	5	0	5	5			50	2	6
31 A	2	PRIMES REGULAR	2	15	1	1	10	2	5	5			25	2	0
	20			GOODS		34	3	7							
		LESS PRIMES TRIAL UNITS	2				1	3							
		LESS RAYFILTA UNITS	3				3	9							
		LESS PRIMES REGULAR UNITS	2				2	6							
						33	16	1							
				1st DISCOUNT		1	13	9							
						32	2	4							
				2nd DISCOUNT		1	12	4							
						30	10	0							
				PURCHASE TAX		7	3	0							
				NET TOTAL £		37	13	0							

RETURNABLE CONTAINERS

5 GALLON MILTON
1 Bottle and 1 Crate
35/ Charge

5 GALLON MILTHEREX
1 Bottle and 1 Crate
35/ Charge

WHERE APPLICABLE THE ABOVE CHARGES ARE INCLUDED IN THE GROSS PRICE COLUMN.

DISCOUNTS ARE CALCULATED ON THE NET LIST PRICE

PLEASE QUOTE
WHEN MAKING PAYMENT

CUSTOMER No. & INVOICE No
221234

CONDITIONS AS TO RESALE PRICES

Notice is hereby given that all goods are sold subject to the observance by the buyer of the fixed wholesale or retail prices (as the case may require) notified from time to time in our price lists, circulars and advertisements issued to the trade, and in the P.A.T.A. List of Proprietary Articles and the supplements thereto. The current resale prices are also shown on this invoice. No discount or gift scheme (whether in cash or kind) may be given. It is a further condition of sale that the buyer, if a wholesaler, shall on resale of the goods impose similar conditions on his retail customers.

CLAIMS FOR DAMAGE OR SHORTAGE: YOU SHOULD NOTIFY THE CARRIER WITHIN 3 DAYS OF DELIVERY FOR DAMAGE AND WITHIN 21 DAYS OF INVOICE DATE FOR SHORTAGE.
A COPY OF YOUR NOTIFICATION TO BE SENT TO US AT THE SAME TIME

W H SMITH & SON (ALACRA) LTD

set are reached. Punched cards pass through the IBM 519 punch at the rate of 100 a minute.

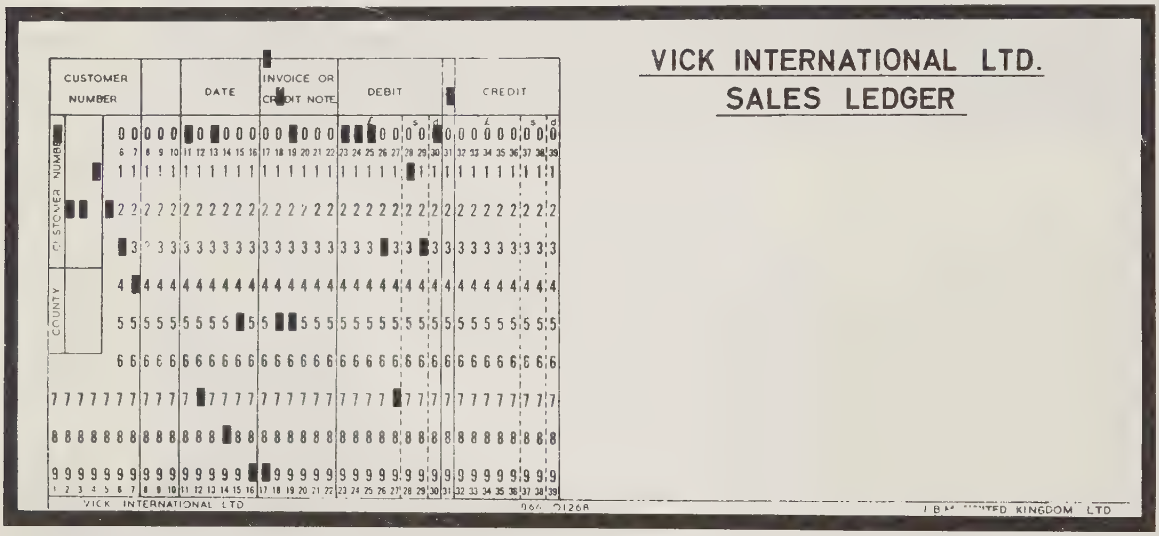
Everything is now ready for the invoices to be printed. An IBM 420 tabulator is used for this work and punched cards arranged in invoice sets are passed through the machine at 80 cards a minute. Printed on each invoice is the customer's name and address, the code number of the depot from which the goods will be supplied and the various items that go to make up the complete order. The gross price of the order is totalled and the discounts are deducted; the purchase tax is then added and the net value printed at the bottom of the invoice. All the data are read from the various cards of the invoice set as they pass through the tabulator. Additions and subtractions are performed automatically by registers fitted to the tabulator. Four carbon copies of each document are prepared in addition to the top copy.

Three of these documents constitute invoices and the remaining two, despatch notes. The right-hand portions of the despatch notes are printed with a pattern of blue squares to obliterate the prices charged for the goods.

Two invoice copies are kept for the records: one is the copy for the sales ledger and the second is filed with the original order form. The third invoice copy is posted to the customer.

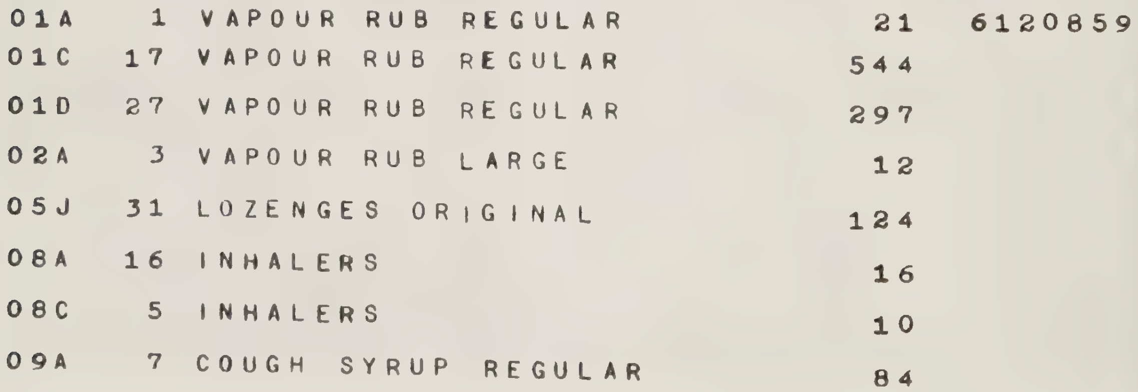
Invoices are not given serial numbers, such numbers, as a rule, having no meaning in a data processing system. A customer's number, however, is significant. Consequently, every time goods are despatched to a particular customer, the invoices will always bear the same number. Only the dates on the invoices will differ.

At the same time as the invoices are being printed, an IBM 517 summary punch, connected to the tabulator, punches the order totals into sales ledger cards. Other information



(Above) Data appearing on an invoice are summarized and punched into a sales ledger card

(Below) Portion of a depot loading statement showing the gross quantities of good ordered



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01A   1  VAPOUR  RUB  REGULAR              21   6120859
01C  17  VAPOUR  RUB  REGULAR             544
01D  27  VAPOUR  RUB  REGULAR             297
02A   3  VAPOUR  RUB  LARGE                12
05J  31  LOZENGES  ORIGINAL               124
08A  16  INHALERS                          16
08C   5  INHALERS                          10
09A   7  COUGH  SYRUP  REGULAR             84
```

Labels needed by the depots for the parcels are printed at a rate of 2,000 an hour

recorded on these cards is the customer's number, the date and a code describing the document to which this data refers (in this case an invoice). Lists and totals are prepared each day from the sales ledger cards so that the sales ledger is always up to date.

After the invoices have been prepared, the name and address cards are removed from the collection of cards and refiled. The product cards that remain are sorted into pack, product and depot number order and, at the conclusion of the day, the cards for each depot are passed through the tabulator. Gross quantities of the products ordered and entered on the invoices that day are listed on the documents produced.

Labels that will be required for the parcels are being printed from the Addressall stencils while this analysis is compiled. Thus, at the end of the day, all the documents needed by a depot to assemble and despatch the goods will have been prepared. These documents are despatched by the evening post in order to arrive at the depot the following morning.

At the depot, the parcels are assembled, packed and labelled. One despatch note is included with the goods; the other is kept at the

A Unipull, which bears the product code number, is placed behind each pack of pre-punched cards

depot and is returned to the head office after the goods have been delivered. Goods are despatched by road directly to the customer from the nearest of ten depots situated at strategic points throughout the country.

Sales statistics

Before the invoices are posted to the customers the information on them is checked. For this purpose the product cards are sorted once more—this time into the following order: Type of customer, pack, product and discount range. Tabulations produced from these cards are examined visually for obvious inconsistencies such as incorrect discount rates. While these checking lists are being compiled, the summary punch connected to the tabulator is programmed to produce summary cards on which are recorded the gross quantities of products ordered that day by every type of customer situated in each county. The size of the packs and the discount allowed are also entered on these cards.

Each week and each month these cards are sorted into order and tabulated to provide the routine sales reports required by management. The cards are then filed away for reference purposes as they comprise a valuable source of information on marketing and sales. Perhaps a local advertising campaign is being run on television or in the provincial Press. During this period management is almost certain to ask for the sales figures in the particular area. These can be obtained quickly by sorting through the sales summary cards and selecting those concerned with the product, the area and the week specified. A tabulation prepared from these cards will show the comparison with other weeks and other areas.

Once the sales summary cards have been created, the original pre-punched product cards can be discarded as they have served their purpose. Actually they are retained for a while in case any queries should be raised. However, to all intents and purposes the information they contain has been absorbed, circulated through the system, acted on and the important data needed for future reference has been abstracted and recorded on the sales summary cards.

Approximately 350 orders are handled each day. The average order contains eight items. In the winter when the demand for medicines is high, orders rise to a peak of about 500 a day. The installation with its present staff of ten can cope with this variation in the quantity of work. To keep the work flowing smoothly, when peak loads occur one operator is always kept in

Copies of pre-punched product cards are prepared automatically on an IBM 519 reproducing punch

reserve. This operator can perform every job in the data processing sequence and is moved from one routine to another as work builds up. The slowest operation is checking. One girl can check about 300 orders, or 2,400 items, a day.

Selecting pre-punched cards is a fairly rapid manual operation and one operator can pull 3,000 cards in the course of a day. Vick International believe that one of their operators may have established an unacknowledged native record for this work. Two years ago, when the Asian 'flu epidemic was at its height and orders reached an all-time high, one girl selected 3,893 cards in 4 hours 10 minutes.

Unipull

What helps in this connection is that behind each pack of pre-punched product cards held in the storage rack is a patented device known as a Unipull, made by Punched Cards Accessories Limited. This consists of a tag fitted with a rubber friction pad. The product code number is displayed on the top of the tag. When a card is to be selected the operator lifts the Unipull and the friction between the rubber pad and the adjacent card raises the card clear of the remainder of the pack, allowing the operator to remove it easily.

New pre-punched cards for the pack are prepared on the IBM 519 reproducing punch. Usually, this task is performed in the afternoons, during lulls in the flow of work.

Obviously, team spirit is most important in work of the character described. To foster this spirit and to maintain morale, Vick International believe in steady promotion. Consequently, rigid and well-defined rules are laid down, and a girl is engaged only if it is considered that she will be able to perform all the jobs connected with the punched card installation. Each new girl starts on the simplest job, in the stencil room, and the other operators are moved up one in the hierarchy. If, at a later date, a girl is found to be unsuitable for promotion to the next job, she is told at once. Then the decision whether to continue in her present job indefinitely or not is left to her. Because of the normal wastage of labour, promotion is regular and certain, until the senior jobs are reached.

The installation was brought into operation on July 1st, 1957. Since then approximately 90,000 invoices a year have been prepared—an average of 350 a day—together with a vast quantity of sales statistics which it would have been almost impossible to produce at an economic price by any other means.

Continuous stationery

for data processing

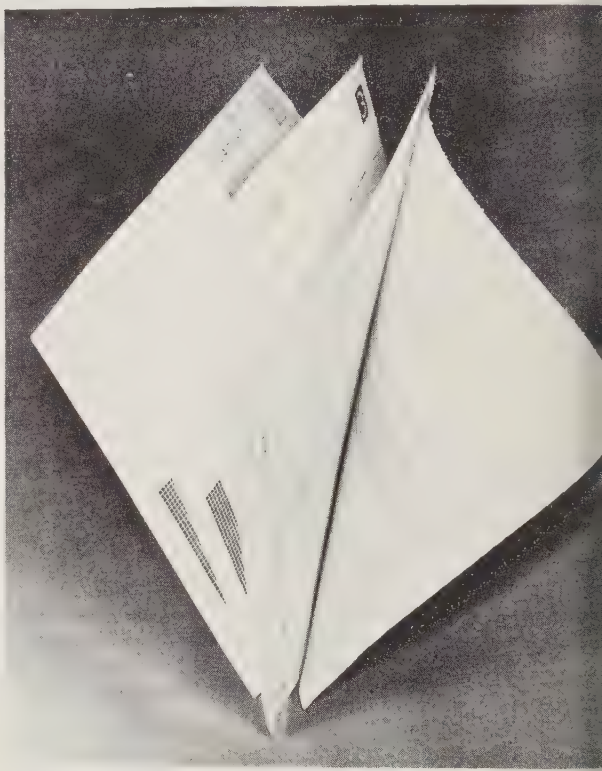
There are major developments in the feeding of forms including wage envelopes into office-type mechanical printing machines. This article, in addition to describing the latest practice, sets out points to be considered relative to design and usage in order to secure the maximum return

In order to print output information at a speed which does not impede a data processing operation it is essential to use continuous stationery. In addition, it is necessary to produce multiple copies so that all the documents that will be required are printed in one operation. Since the main object of data processing is to reduce the quantity and variety of the documents in circulation, those that are retained must display the pertinent information clearly and they must be easy for clerks to handle during subsequent operations. For these reasons, the design of individual forms, their arrangement in "sets" and their use as continuous stationery, require careful planning.

As the word implies, a "set" consists of several documents gathered together with one superimposed upon another. Carbon papers are interleaved between the sheets and as data are printed on the top document, copies are reproduced on the documents underneath.

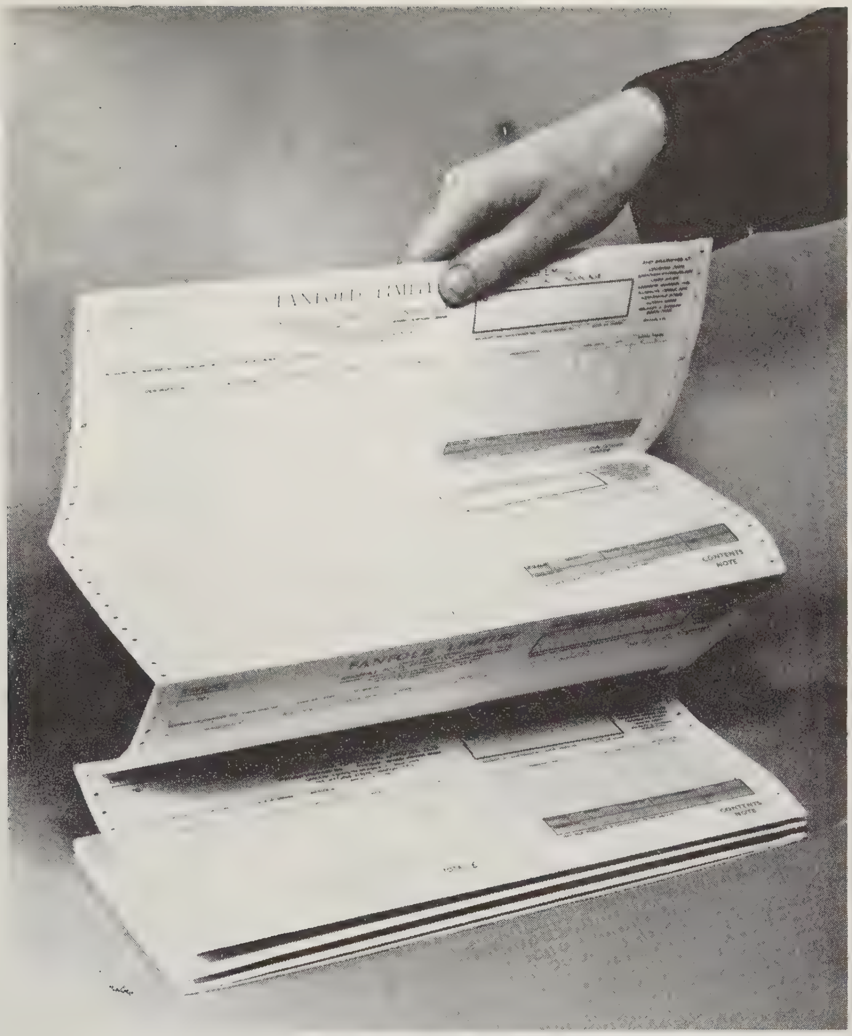
Continuous stationery consists of sets of documents joined head to tail in a continuous length and folded zig-zag fashion into packs of a size convenient for handling purposes. This is shown in the illustration on the opposite page. Each set of documents is divided from its neighbour by perforations which run transversely across the width of the paper.

There are two kinds of continuous stationery, fanfolded and interfolded. Fanfolded stationery consists of one wide web of paper that is first folded fan-wise along vertical perforations so that each document in the set remains connected to its neighbour, as shown in the illustration. Then the continuous length of fanfolded stationery is folded a second time in a zig-zag fashion to make a pack.



A fanfolded seven-part document set. Each form is joined to its neighbour along one vertical edge

On the other hand, with interfolded stationery each document in the set is printed on a separate web of paper and adjacent sheets are not joined along their vertical edges. These separate webs are gathered together and then folded transversely in zig-zag fashion to form a complete pack. Both kinds of stationery can be supplied



Continuous stationery is folded, zig-zag fashion, into packs of a convenient size for handling

with holes punched down each edge to engage with sprocket drives that feed the continuous stationery to the printer. Incidentally, the size and spacing of these sprocket holes have been standardized so that any automatic document-feed mechanism can handle any type of continuous stationery. The holes are $\frac{5}{32}$ inches in diameter and are spaced half an inch apart.

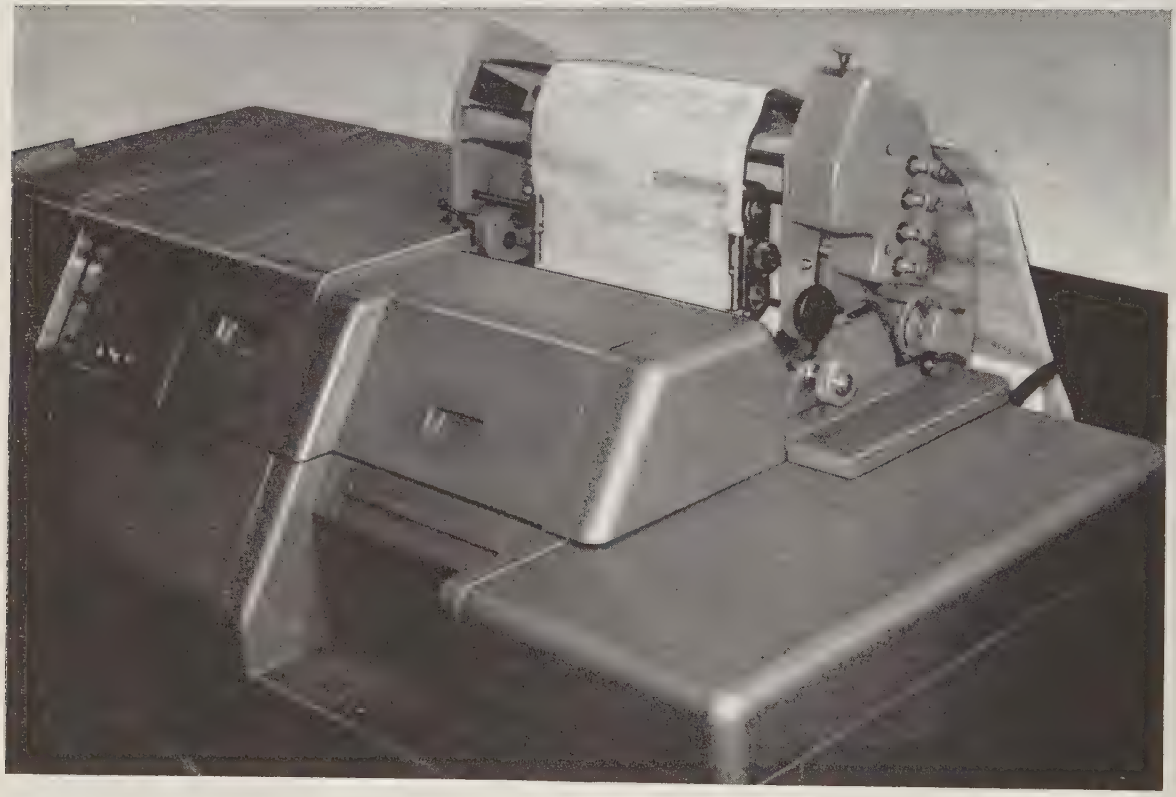
After printing, the carbon papers interleaved between the sheets are discarded and, although a cheap one-application carbon paper is used, the expense incurred is considerable. In order to reduce this cost, special continuous stationery carbon feed mechanisms have been designed, One of these, known as a Carbaline feed, can be fitted to most of the printers available to-day.

The Carbaline feed performs two functions. It feeds the webs of paper in and out of the printer and maintains them in perfect register. It also interleaves carbon papers between the documents of the set and moves these carbons, a fraction of an inch each time, after a line of characters has been printed. By this means the amount of carbon paper used is greatly reduced.

A Carbaline feed mechanism consists of a number of horizontal spindles and a series of sprocket tractor drives positioned above the platen of the printer. If a five-part document set is to be printed, four rolls of carbon are fitted to the feed mechanism and the five continuous webs of interfolded stationery are positioned to pass one on each side of the individual rolls of carbon. The carbons are pulled down between the webs of paper and the composite sandwich, consisting of paper and carbon sheets alternately, is wound over the platen of the printer in the normal way.

The sprocket tractor drives engage with the holes in the continuous stationery and feed it to the platen of the printer. Friction carries the carbons along with the stationery as it travels forward. Because the carbons are not directly driven they do not advance as far, or as fast, as the documents. In this way the carbons "creep" and a good carbon impression is always obtained without wastage.

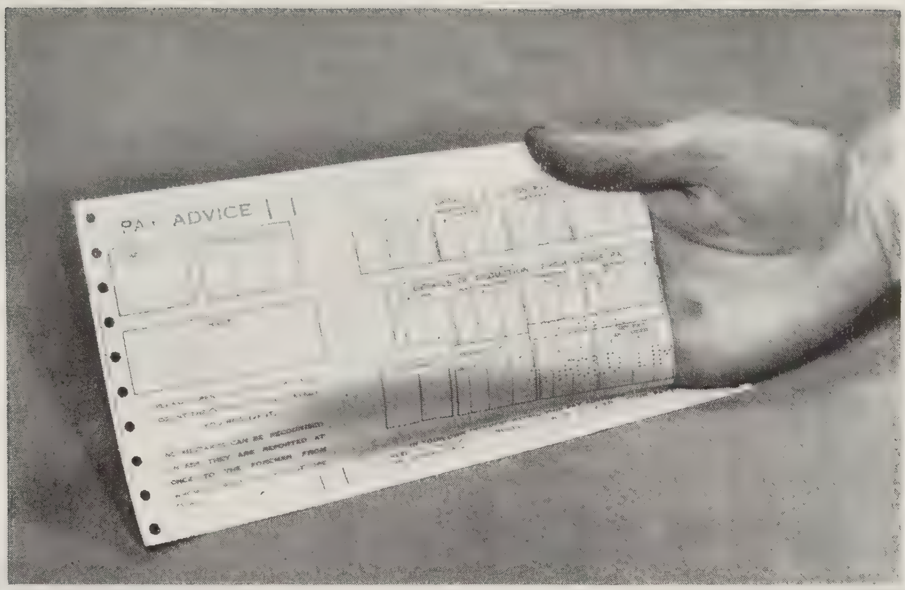
A recent development in continuous stationery is the introduction, by Fanfold Limited, of continuous wage envelopes. Wage data can be printed directly on to the envelope by a standard punched card tabulator or computer printer, thus eliminating the need to prepare and insert separate payslips. One industrial concern stated recently that, as a result of using continuous wage envelopes, the time required to prepare wage packets has been reduced by 30 per cent.


A Carbaline feed fitted to a Hollerith tabulator

A continuous wage envelope consists, primarily, of a sheet of strong paper folded back on itself. The two long edges are glued together and, as shown in the accompanying illustration, the short edge—at the flap—is left free and is the entrance to the pocket, or envelope.

The envelopes are joined in a continuous web, with sprocket holes punched along the sides. Each envelope is, of course, divided from its neighbour by a perforation.

These continuous wage envelopes can be fed through a punched-card tabulator and handled in the same manner as conventional continuous stationery. After details of an employee's pay have been printed on each envelope, the envelopes are separated and the money is inserted by hand. The right hand edge of the envelope is coated with an impact glue and, when it is folded over as a flap, it adheres immediately, sealing the money inside. In its closed position, the flap covers the details of the



A continuous wage envelope. These are handled as conventional continuous stationery and wage data are printed directly on the envelope

employee's pay; thus this information remains confidential. Various types of continuous wage envelopes are made, including one with a transparent back that enables the contents to be checked.

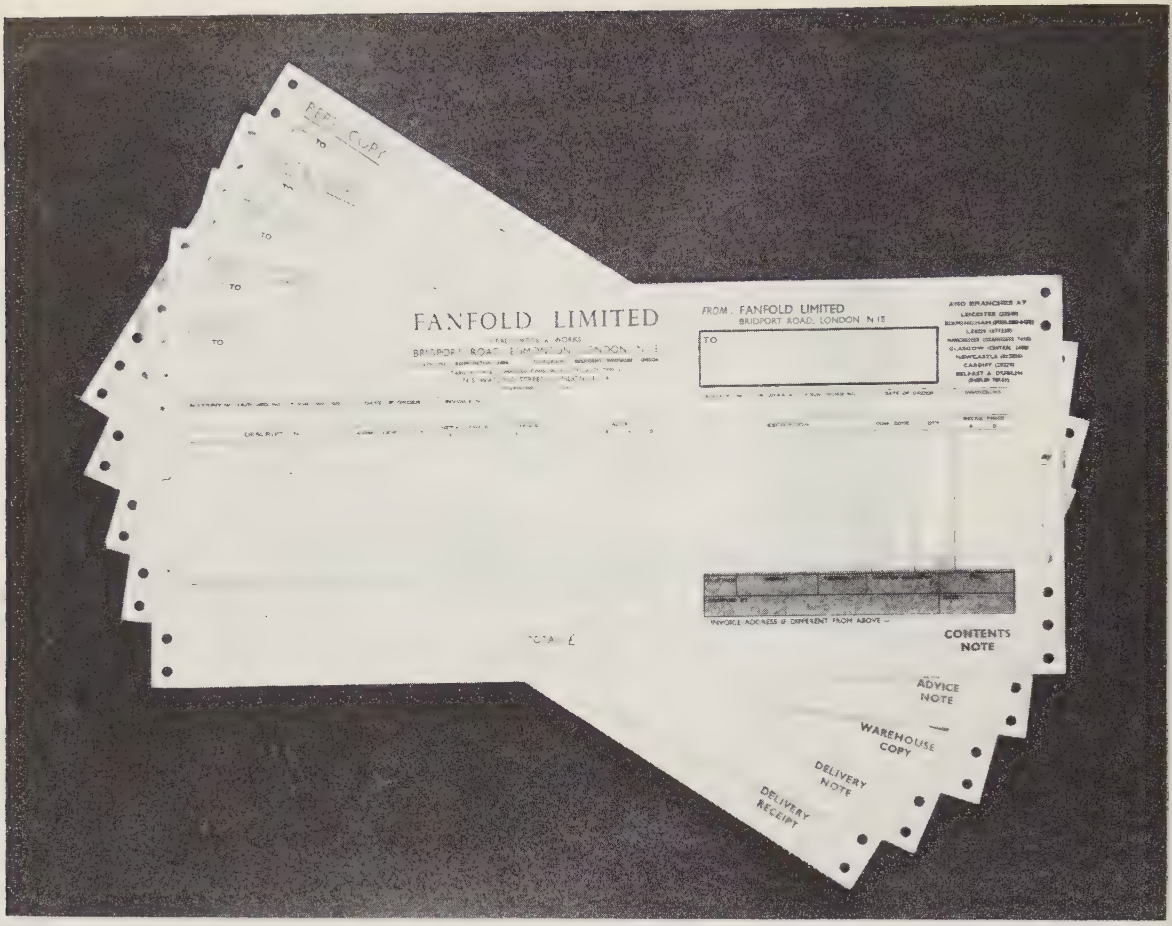
Naturally, the choice and design of continuous stationery is largely governed by the type of printer, the types of feed mechanism, the use to which the documents will be put after the initial entries have been made and whether further entries will be made later. It is important, therefore, that, as a preliminary, there is clear understanding of the documentation required and its use—only then can the individual forms be designed satisfactorily and produced economically.

Design of forms

To show how the nature of the work influences the layout and arrangement of the individual forms the design of two sets of documents will be described. The first set is for use with a Hollerith 902 UPF punched-card tabulator. The problem was to produce ten documents on which the information was to be substantially the same, but from some of which price details were to be omitted. Another point: additional entries were to be made by hand on some of the documents at a later stage in the data processing sequence. As it happens, ten documents is more than a Hollerith tabulator will produce in the normal way; however, by utilizing the capacity of the machine to print both alphabetical and numerical characters at all positions across the line, it was possible to design and arrange the forms side-by-side, in pairs, on five separate webs or sheets of paper. Each sheet is perforated from top to bottom and the two documents can be separated easily. The documents which contain the least information were grouped on the right. The ten documents are:—On the left, the invoice, copy invoice, day book copy, statistical copy, and representative's copy; on the right, the contents' note, advice note, warehouse copy, delivery note, and delivery receipt.

To keep costs as low as possible, this continuous interfolded stationery was designed for use with a Carbaline feed. Consequently, as there are no interleaved carbons left between the documents after a set of documents has been printed, carbon is provided in certain areas on the reverse side of the printed forms so that copies of subsequent handwritten entries can be obtained.

In the second example, a set containing six documents was required. After the data had been printed the original set was to be split into two smaller sets, one containing two forms and the other containing four. The docu-



A ten-part document set printed on five separate webs of paper each of which is divided vertically to provide two documents. Data are recorded on all ten forms simultaneously

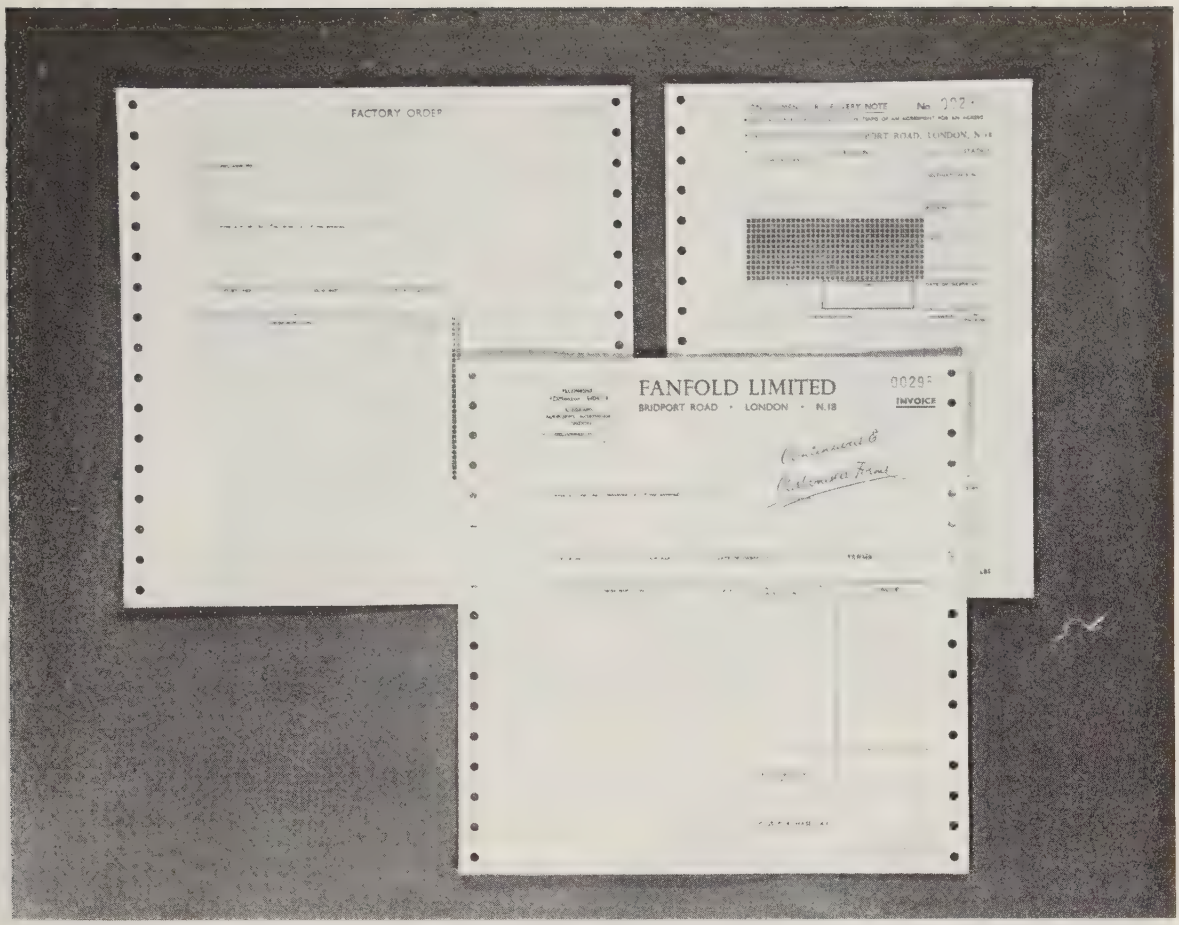
ments in both of these smaller sets were to remain joined together during subsequent handling.

The sets comprising two forms were to be retained in the office, while the four-part sets were to travel through the works, further information being added en route, until they arrived at the despatch bay where each set would be split again, this time in half. One half was to accompany the goods as consignment and receipt notes, while the other two forms were to be returned to the office so that the remaining documents could be completed and released for distribution.

A fanfold design was adopted for this purpose because the documents remain joined together, complete with carbon papers, after the original set is subdivided. Carbons of differing widths are interleaved between the forms. In this way, unnecessary data can be eliminated from some of the copies produced.

The procedure described reveals the simplicity with which well-designed document sets can be handled. It will be realized, too, that with the manual work connected with the handling of documents reduced to an absolute minimum, administrative efficiency can match the efficiency with which the data are prepared by machine.

The detailed design of individual forms is best achieved by preparing an exact drawing of each form on a special layout sheet. This consists of a ruled paper that indicates the line and letter spacings of the printer. Areas are enclosed by ruled lines to show the maximum number of digits and the position to be occupied by the various items of data. From this preliminary rough sketch a final pencil draft is prepared which includes all the information such as company headings which are to appear on the final form. Apart from the actual design of the



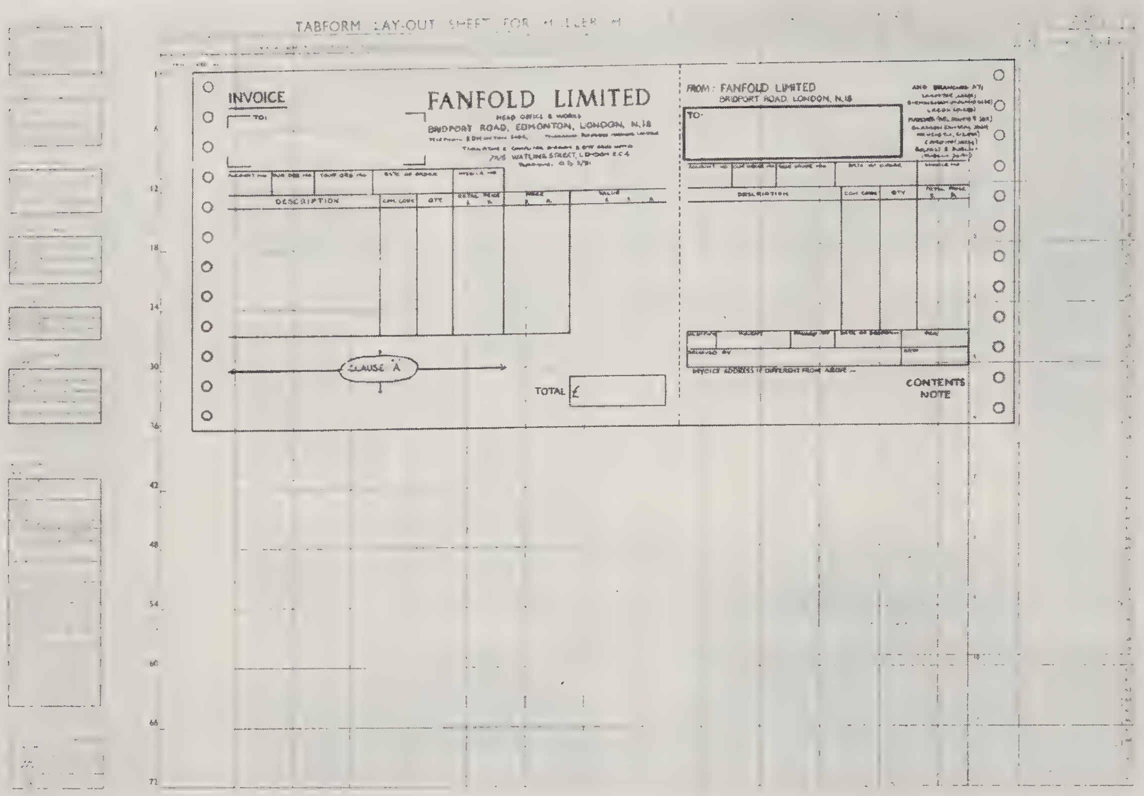
A six-part document set of fanfold design. The set can be subdivided into three smaller sets, each containing two documents. Each pair of forms remain attached with interleaved carbon

forms, other factors that must be considered include the grade and quality of paper, the type of carbon paper, colours of ink and method of binding file copies. The paper, of course, must not only be satisfactory for the machine on which it will be printed, but must also be able to withstand the handling it will receive afterwards. Grades of carbon paper need to be chosen with care as the quality of the copies obtained varies from one type of printer to another.

Proof printing

When all the details of the form layout have been settled, proofs are obtained in the shape of individual document sets and then as continuous stationery. The continuous proof, of course, is mounted on the actual printer to be used for the work and a trial printing run performed. Experience has proved that the checking of continuous proofs in this manner is invaluable, as no two printing machines, even of the same kind, print columns at exactly the same spacing. Where several printing machines are available and the same continuous stationery is to be employed on all of them, the machines must be specially aligned to print at a common uniform spacing.

A problem which arises occasionally, especially with computers, is how to obtain more than the usual five or six copies—the output printer's normal limit—without repeating any of the data processing operations. One solution is to prepare a carbon master copy that can be transferred directly from the output printer to a spirit duplicator. Hectographic carbon, such as is used for this purpose, is a special grade of carbon which can be transferred from a master document on to a plain sheet of paper when they are brought together in direct contact.



Form design drawn on a typical layout sheet. The small ruled squares indicate all the positions in which the tabulator—in this case a Hollerith 901*—could print a character*

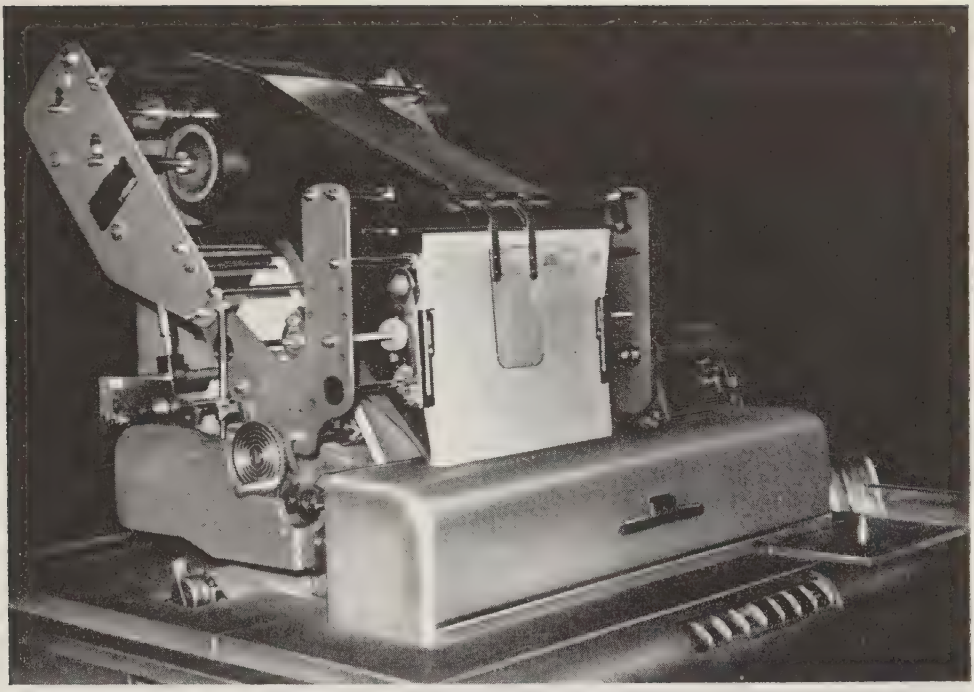
As the hectographic carbon depreciates with each printing cycle, the number of copies that can be made depends upon the weight of the hectographic carbon impressed upon the master copy. Up to 200 copies can be obtained from a master copy prepared on a tabulator. As might be expected, hectographic carbon is expensive and to conserve its use a modified Carbaline feed unit is often fitted to the printer.

Separating continuous stationery

So large is the number of documents used by many commercial houses that it can be desirable to have some mechanical means of separating the continuous stationery into individual sheets. Two types of machine are available for this work, the form burster and the continuous form guillotine. The form burster consists of two sets of power-driven rollers between which a single web of stationery is passed. The first pair of rollers rotate at a slower speed than the second with the result that the paper is pulled taut as it passes between them and will burst along the perforations. An adjustable cutter can be provided that splits the web of continuous stationery lengthwise to part documents which have been printed side-by-side. The burster handles stationery at the rate of 90 feet per minute.

The automatic guillotine is designed to divide continuous stationery that is still retained in the form of sets. It separates these by chopping along the line of the transverse perforations. Both types of machine can trim off the margins containing the sprocket holes.

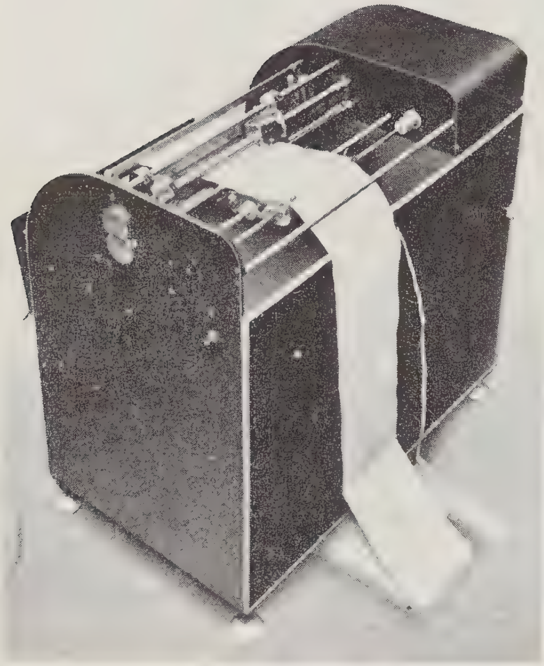
A simple multi-compartment storage rack has been designed to hold the packs of continuous stationery ready to be fed to a machine. It also stores the packs after the printing operation. Although sets of documents are fed to the printer by the Carbaline attachment, it will be recalled that the webs of paper are not attached to each other. Consequently, the different sheets can be separated from each other as they emerge



(Above) Carbaline feed equipped with a hectographic carbon attachment to produce master documents for spirit duplicators

(Right) A form burster that trims off the sprocket-punched margins and separates the individual documents from a single continuous web of paper

(*Left*) *Automatic guillotine that separates continuous stationery into individual document sets and also trims off the sprocket-punched margins*

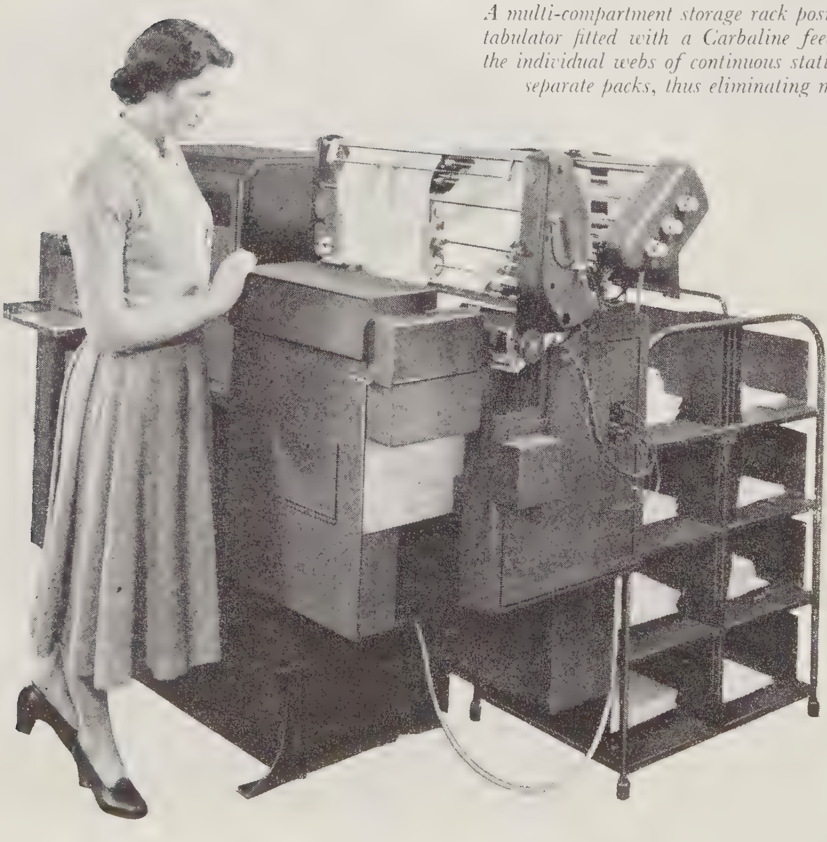


from the feed mechanism and refolded into individual packs. This dispenses with a considerable amount of manual sorting.

Major development work on continuous stationery and the associated auxiliary equipment for punched-card tabulators began in earnest shortly after the war. The advent of the computer added impetus to this work.

It is obvious that, with the increasing mechanization of offices, continuous stationery will be used even more widely in the future. Hence, it is suggested, companies need to examine carefully the design, application and use of continuous stationery, so that later developments are not hampered by a lack of suitable standards that could have been adopted quite easily, from the outset.

A multi-compartment storage rack positioned at the rear of a tabulator fitted with a Carbaline feed. After the printing, the individual webs of continuous stationery are refolded into separate packs, thus eliminating manual sorting



A mechanical filing system

Push-button machines which place any given set of punched cards in front of the operator within, on average, 2½ seconds

A series of relatively simple electro-mechanical filing machines is now available. They are designed to accommodate three standard sizes of index card – 5 × 3 inches, 6 × 4 inches and 8 × 5 inches – and standard 80-column punched cards 7⅜ × 3¼ inches but can also house many other sizes and shapes of document. As many as 400,000 punched cards can be under the control of a single, seated operator. A machine storing 126,360 punched cards occupies a floor space of 5 feet 10 inches by 3 feet 1 inch

ALTHOUGH a simple operation, selecting punched cards in readiness for processing data probably absorbs more working hours than any other job performed in a punched-card installation and so high are the speeds at which punched-card machines operate that often the factor limiting the work produced by a department can be the rate at which punched cards are retrieved from the files and arranged in packs for feeding to the machines.

Many designs of punched-card storage racks and trays are in use nowadays, but in all cases, when cards are to be selected, the operator has to walk to the filing cabinet where the particular cards are stored. In large filing rooms each girl may walk a considerable distance and open and close many drawers in order to select all the cards needed for a particular job. In one investigation it was discovered that, during the course of a working day of 7¼ hours, one

To select a card the operator presses a button and the carrier containing the card is brought to her

Capacity and size of typical Kard-Veyer machines

Model Number	Width	Depth	Height	Carrier Length	Card Size	Card Trays per Carrier	Carriers per Unit	Filing Inches per Unit
	Inches							
4350	50½	37	43	27	5 × 3	5	13	780
					7⅜ × 3¼	3	13	468
					8 × 5	3	8	288
4370	70	37	43	46½	5 × 3	8	13	1248
					7⅜ × 3¼	6	13	936
					8 × 5	5	8	480
4386	86½	37	43	63	5 × 3	12	13	1872
					7⅜ × 3¼	8	13	1248
					8 × 5	7	8	672
5970 (single unit)	70	37	59	46½	5 × 3	8	21	2016
					7⅜ × 3¼	6	21	1512
					8 × 5	5	14	840

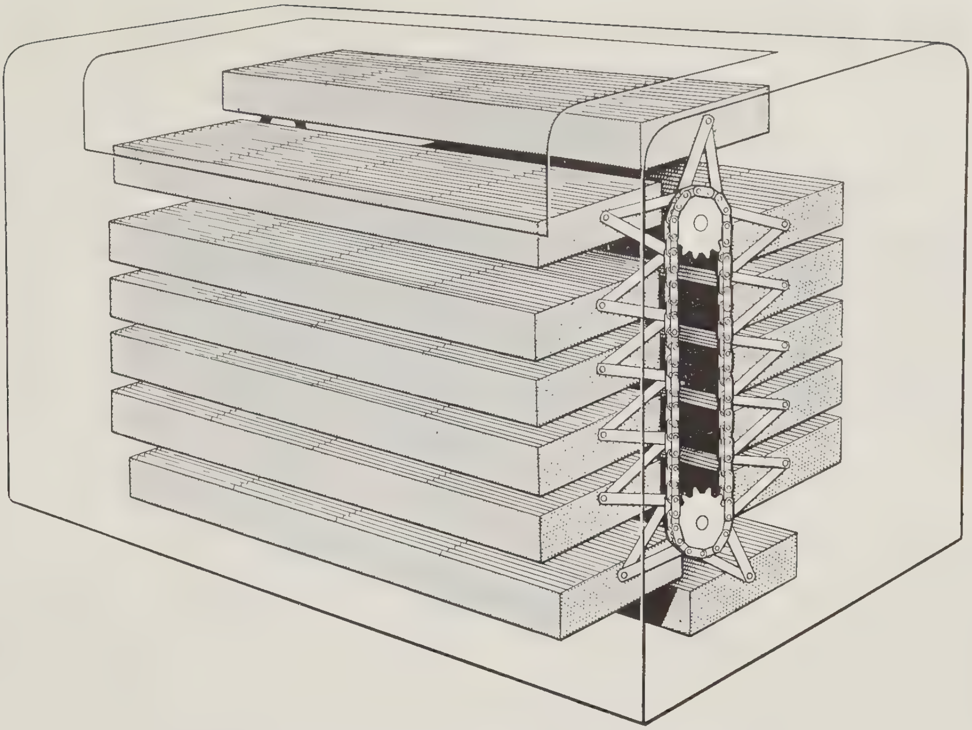
operator opened and closed 88 file drawers to select 1,151 cards. To speed up this work, Remington Rand Limited have introduced a series of automatic filing machines known by the generic title of Kard-Veyer. These consist of eight to 21 long carriers which are supported on a chain-driven transporting system and arranged rather like the chairs of the big wheel seen at fairgrounds. The carriers, of course, are freely supported on pivots so that they always remain the right way up as the drive carries them up, over the top and down in the continuous circular motion.

This mechanism is contained within a cabinet with an aperture at the top. The operator sits in front of the cabinet and can easily reach all the trays on the particular carrier that is halted at the opening.

A push button is provided for each carrier and the drive automatically circulates the carriers and halts them when the one selected is in position next to the operator. The drive moves the carrier either forward or backward to bring the selected unit to the operator by the shortest possible path. On average, the filing tray is brought to the operator within 2½ seconds of the button being pressed.

Controls for the machine are very simple and consist of a mains power on-off switch, four machine-operating buttons—stop, reset, up and down—and one button for each carrier. A label next to each button identifies the cards stored on the particular carrier. Two indicator lights are also fitted to show whether the machine is ready for operation or not. A small ledge and an offset table are provided on which the operator can stack cards and arrange work documents.

An obvious advantage of this machine is that it forms a static work-station where the operator can be seated. Supervision is easier. The machine also, of course, provides compact storage accommodation for a large number of cards.



Mechanism of a Kard-Veyer. Pivoted carriers supported between two chain drives bring the required unit to the opening at the top of the cabinet

The machine illustrated is type Number 4370. When equipped to accept standard 80-column punched cards ($7\frac{3}{8} \times 3\frac{1}{4}$ inches) it is fitted with 13 carriers each holding six trays of cards. This represents 936 inches of filing accommodation and provides sufficient space for 126,360 cards. The 4370 machine costs £1,295 and occupies a floor area 5 feet 10 inches by 3 feet 1 inch. Kard-Veyers of other capacities are made.

Typical capacities of other models are shown in the accompanying table. Model 5970, the largest, consists of two units. These are placed opposite each other on a platform, so that an operator, on a swivel chair, can make use of both. Over 400,000 cards can be filed in these two units. A machine of this type costs £3,040.

Other types of card can be housed in these machines. In fact, some of the biggest installations in the United States are used for filing conventional handwritten or typed index cards. Kard-Veyers built for this purpose accommodate index cards of the three most popular sizes: 5 × 3 inches, 6 × 4 inches and 8 × 5 inches. Of course, the machines can easily be adapted to suit many other styles of card.

Several safety devices are provided to protect both the operator and the machine. The most important is a trip wire fitted across the entire width of the opening. When a hand or arm comes in contact with the trip wire the machine stops instantly. In the event of an emergency stop, the machine can only be restarted by pressing the reset control button and then reselecting the required carrier. Another feature is that if the flexible cover, that closes the opening when the machine is not in use, is not pushed back to its full extent, a switch prevents the machine from being operated.

Servicing requirements are simple because of the relatively simple nature of the electro-mechanical units. Incidentally, because the machines are installed in offices, special attention has been paid to the electric motor and mechanical drives to ensure a low noise level and vibration-free operation.

Initially, these machines are being imported by Remington Rand from their parent company in the United States, but it is expected that in due course manufacture will start in Great Britain.

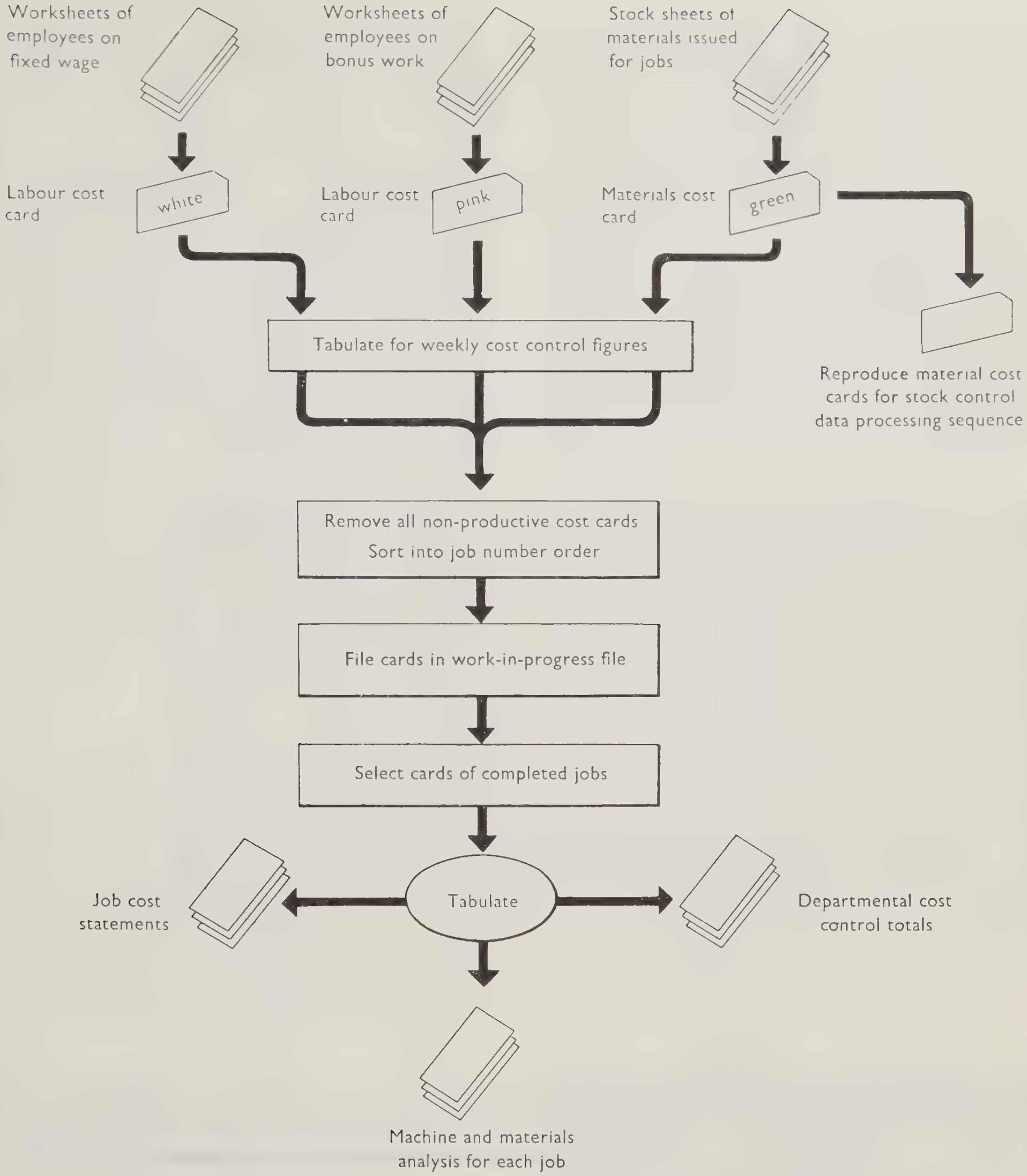
JOB COSTING

—and many other worth-while tasks on a small punched-card installation

Small companies, as well as large organizations, can benefit from the use of data processing machinery. Eleven years ago, a printing works, employing 360 people, installed 36-column punched-card machines for costing and accountancy work. Since then, a large number of different jobs have been loaded on to this equipment. Now the sorter and the tabulator are in continuous operation, and utilization rates are being achieved which the designer of the equipment probably never foresaw or intended. Throughout this period the mechanical accounting section has never failed to produce work on time and has never had to resort to emergency manual routines

CHAPEL RIVER PRESS employs 360 people and uses a small punched-card installation for costing and accountancy work connected with the business of letterpress printing and bookbinding. Payroll, job costing, sales analysis, purchase analysis, stock control, these are but a few of the many everyday tasks performed with the aid of the punched-card machinery. The equipment comprises a handpunch, three automatic keypunches, a verifier, a reproducer, a sorter and a tabulator. Work performed is confined to punching, sorting and tabulating. No arithmetical calculations are made beyond the compilation of sub-totals and grand totals on the three adding registers fitted to the tabulator. The scope of such an installation is limited in comparison with those employing calculators. Nevertheless, since this installation can sort and present existing data in different contexts—tasks which form a considerable proportion of any clerical procedure—much valuable work is accomplished both rapidly and accurately.

The mechanized accounting section at The Chapel River Press. Other machines used include a reproducing punch, a verifier and a sorter


Worksheets of employees on fixed wage
Worksheets of employees on bonus work
Stock sheets of materials issued for jobs
Labour cost card
white
Labour cost card
pink
Materials cost card
green
Reproduce material cost cards for stock control data processing sequence
Tabulate for weekly cost control figures
Remove all non-productive cost cards
Sort into job number order
File cards in work-in-progress file
Select cards of completed jobs
Tabulate
Job cost statements
Departmental cost control totals
Machine and materials analysis for each job

A staff of five operate the machines. Usually, three are employed on punching cards; the supervisor operates the sorter and tabulator, distributes the work, checks the results and generally administers the section while the remaining operator controls the other machines, corrects erroneous cards and checks all job reference numbers. The section was established 11 years ago and the equipment was supplied by Powers-Samas* at a cost of about £6,600. Emergency manual systems, devised to cope with the work in the event of the equipment failing, have never had to be brought into use.

A 36-column card, one of the smallest punched cards made to-day, is used. By modern standards the equipment is obsolescent—36-column cards have since been replaced by 40-column cards. Nevertheless, the machines continue to function regularly and efficiently, and the installation performs all the work required of it. Year by year the number of jobs tackled has increased until, nowadays, both the tabulator and the sorter are in almost continuous use.

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*Powers-Samas is incorporated in International Computers and Tabulators Limited.

Of the many tasks performed by these machines, job costing is the most rewarding. This presents a difficult problem in the printing industry, especially where a large number of small orders is handled. The expense incurred in assessing costs can become disproportionate to the value of the work, unless the required information can be obtained easily and automatically.

Worksheets

At The Chapel River Press each order to print a particular item is given a job number by which it will be identified during its progress through the works. When each operation is completed, the printer enters on his worksheet, against the appropriate number, the time spent and the machine used. There are two types of worksheet, depending on whether the printer is paid a fixed hourly wage or an hourly wage plus an incentive bonus. Every evening the worksheets are collected and sent to the cost office.

On the worksheets of printers not employed on bonus work will appear the job numbers and the number of hours (given to the nearest tenth) worked on each operation. At the cost office, additional data are entered manually. First, a code number, identifying the operation performed, is entered against each job. Code numbers from 1 to 49 indicate that the cost is chargeable to the job; all other code numbers represent overheads that are not directly chargeable to the job. Examples of the latter are the cleaning, oiling and maintenance of machines.

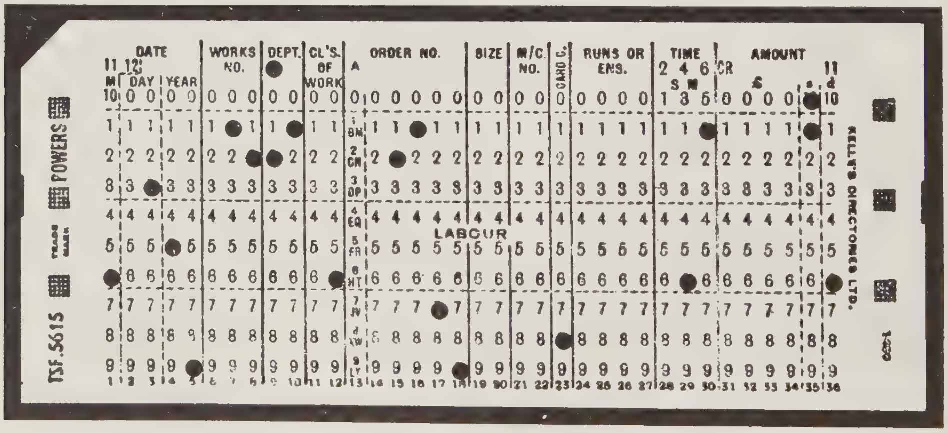
Next, the cost clerk enters the hourly rate to be charged for the particular operation. A consolidated rate is used that includes the hourly cost of the man's labour, the cost of the machinery used and the appropriate proportion of the departmental overheads. This consolidated rate is, of course, based on the productive time it is estimated the particular machine will be used during the year. From these data the clerk calculates a price for the operation which is entered on the worksheet.

Worksheets for printers on bonus work, although of different design, contain similar basic data to those recorded on the hourly rate worksheets. Job numbers, class of work code numbers and time worked are entered daily and the completed sheets are returned to the cost office. Here, the cost clerk enters the standard times allowed for each operation.

Standard minute value

Each operation included in the bonus system has a standard time—what is termed "the standard minute value"—that has been agreed by the incentive bonus committee on which both the employer and employees are represented. For example, when the printer has to correct a number of lines of print, the standard minute value entered may be $\frac{32}{100}$. This means that every 100 lines of print corrected represents 32 standard minutes work.

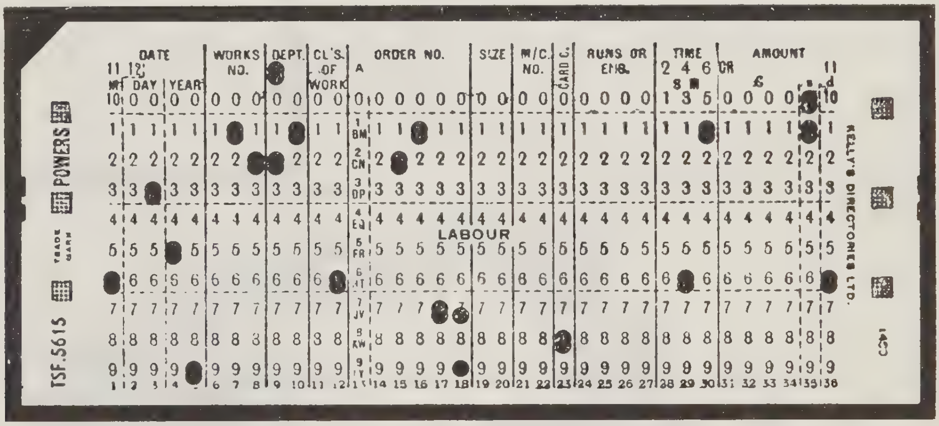
Cost data are punched into 36-column cards. This card is a labour cost card and contains all the data concerning one printing operation. An average of 7,500 labour cost cards are prepared each week



Standard minute times for all the jobs listed on a worksheet are added up and the total is written at the bottom. Bonus earned is based on the difference between this figure and the actual number of minutes worked that day. The cost of each job is then calculated. This concludes the work of assembling labour cost data.

Worksheets of both types accumulate in the cost office and are sent to the machine accounting section daily. Here, the data from the worksheets are transcribed on to punched cards by keypunch operators. All the data referring to one operation are contained on one line of the worksheet and a card called the labour card is punched for each entry.

Data of hourly rate jobs are punched into white cards and data of bonus paid jobs into pink cards. Both types of card are identical in design. On the left of the card is entered the date, printer's clock number, department, class of work and job order number in that sequence. Cost in £ s. d. is entered in the final six columns on the right of the card.



Data entered on a card are verified by a second operator who repeats the data transcription operation. Identical recordings produce oval holes. Two separate holes indicate an error (example in column 18)

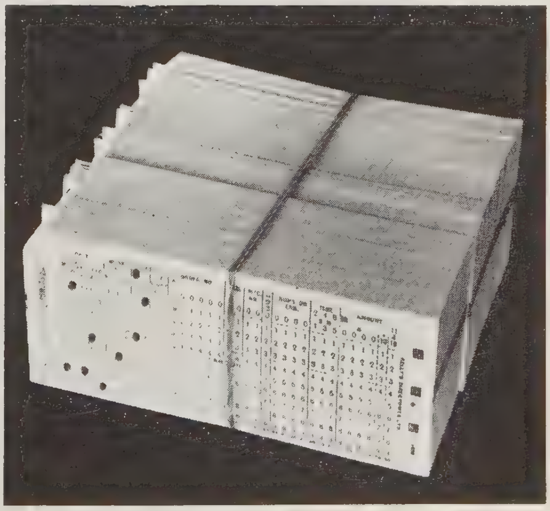
Punched cards and worksheets are then passed to a second keypunch operator for verification. The transcription is repeated, the same data being entered into the same card. The second set of round holes punched are displaced a small distance vertically in relation to the first set of holes. Identical recordings will, in consequence, produce oval perforations. Cards are then passed through an automatic verifying machine which places a coloured marker card next to any card containing a round hole. Round holes, of course, indicate that an error has been made. Incorrect cards are withdrawn from the pack and replaced by correctly punched cards. The automatic verifying machine checks 200 cards a minute.

A good keypunch operator can prepare 700 labour cards an hour. Between 7,000 and 8,000 labour cards are prepared each week.

All the labour cards for one week are passed to the sorter. White cards and pink cards are handled separately. Cards are sorted into class of work performed and departmental number order. Printed lists are then produced by passing the cards through the tabulator.

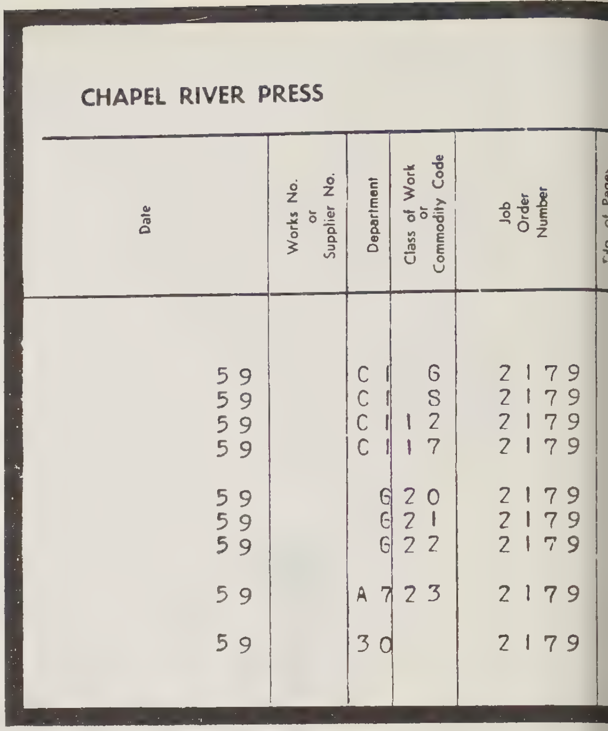
From the white cards a list is prepared giving the cost value for the week of all work performed at hourly rates. Numbers of hours worked and total values are given for each department.

The verifier automatically places a protruding marker card next to each card incorrectly punched



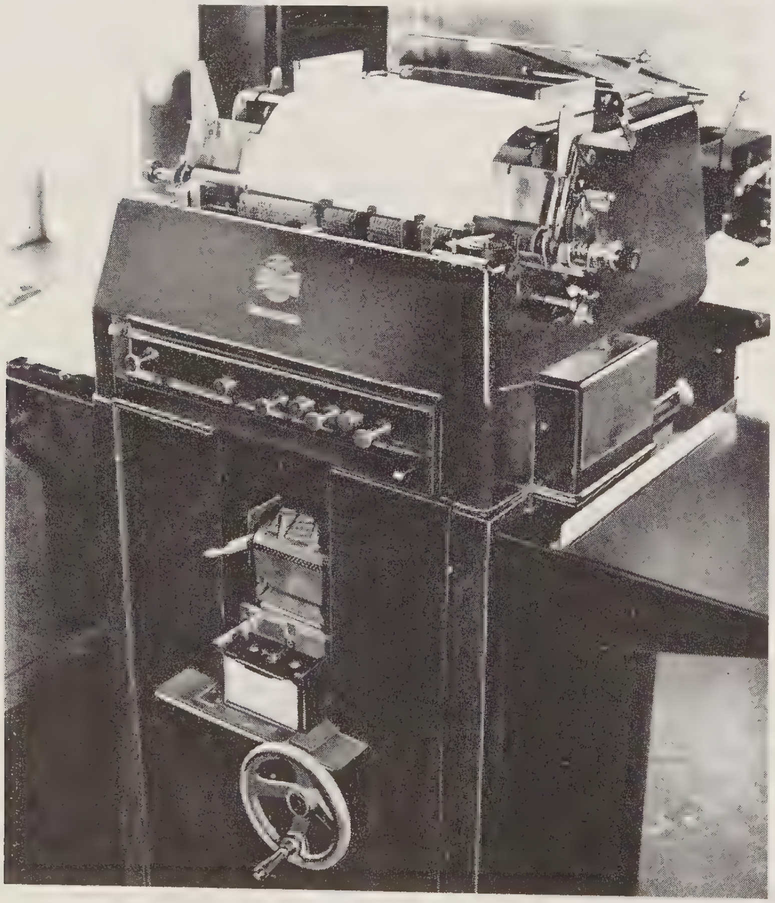
Value of work produced by each printing press is also given, together with an analysis of all productive work performed, including the number of printing runs. Similar analyses are prepared of non-productive work for each machine, together with departmental totals. Examination of the latter document will disclose any abnormal conditions that may have arisen: for example, when certain machines were idle awaiting work. With this knowledge, management can investigate the reasons and take any appropriate action.

The tabulator prints data at a speed of 80 lines a minute, each line containing up to 40 characters. All sub-totals and grand totals are compiled automatically on three adding registers fitted to the tabulator. Examples of such data are cost totals for individual departments and individual printing presses. These are then key-

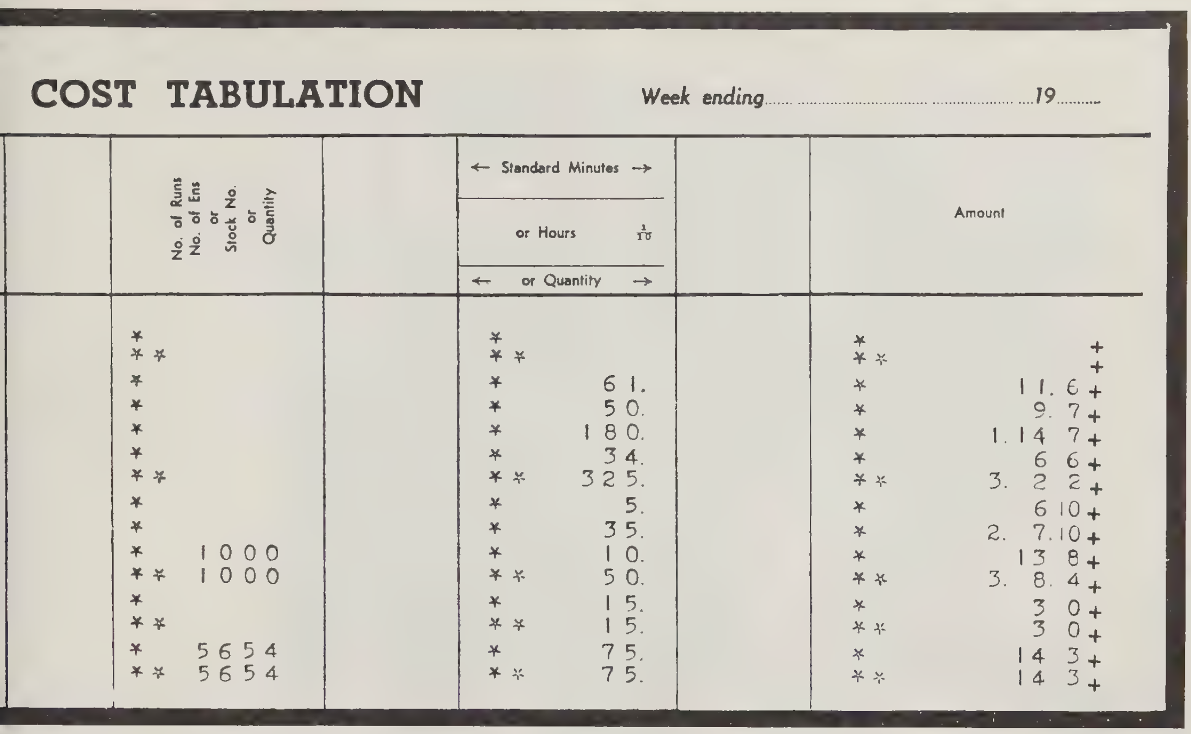


CHAPEL RIVER PRESS

Date	Works No. or Supplier No.	Department	Class of Work or Commodity Code	Job Order Number
5 9		C 1	G	2 1 7 9
5 9		C 1	S	2 1 7 9
5 9		C 1	1 2	2 1 7 9
5 9		C 1	1 7	2 1 7 9
5 9		G	2 0	2 1 7 9
5 9		G	2 1	2 1 7 9
5 9		G	2 2	2 1 7 9
5 9		A 7	2 3	2 1 7 9
5 9		3 0		2 1 7 9



Data are read from punched cards and printed at a speed of 80 lines a minute by this tabulator



COST TABULATION Week ending .... 19......

	No. of Runs No. of Ens or Stock No. or Quantity		← Standard Minutes → or Hours $\frac{1}{10}$ ← or Quantity →		Amount
	*		*		* +
	* *		* *		* * +
	*		* 61.		* 11.6 +
	*		* 50.		* 9. 7 +
	*		* 180.		* 1.14 7 +
	*		* 34.		* 6 6 +
	* *		* * 325.		* * 3. 2 2 +
	*		* 5.		* 6 10 +
	*		* 35.		* 2. 7.10 +
	* 1000		* 10.		* 13 8 +
	* * 1000		* * 50.		* * 3. 8. 4 +
	*		* 15.		* 3 0 +
	* *		* * 15.		* * 3 0 +
	* 5654		* 75.		* 14 3 +
	* * 5654		* * 75.		* * 14 3 +

When a job has been completed all the cost cards relating to it are tabulated to produce a cost statement

punched into statistics cards—if a summary punch were available this work could, of course, be done automatically. From these statistics cards, printed cost statements are prepared at the end of the year or at intervals throughout the year, whichever is required.

A similar range of documents is produced from the pink labour cards.

Costs of materials

Prices of material used must also, of course, be compiled before detailed job cost statements can be prepared. For this purpose, the storekeeper records in writing the amount of paper and other materials issued for particular jobs. At the end of the week these materials issue sheets, as they are called, are sent to the cost office. Here a clerk calculates the cash value of each item. These sheets are then passed to the machine accounting section where the data are punched into a green "materials" card. Each card contains data relating to an issue of material for a particular job. From 300 to 400 materials cards are punched each week.

Materials cards are sorted into departmental order and passed through the tabulator. The printed documents that emerge specify all materials issued, job numbers and the quantity and value of each issue and also list departmental totals.

At this stage all the costs of work completed are recorded in punched cards and printed statements of costs incurred during the previous week have been produced. Labour cost cards for non-productive work are then sorted out. Finally, all the remaining cards are sorted into job number order and stored in a work-in-progress file.

Consequently, as a particular job proceeds through the printing works the cards relating to it in the work-in-progress file increase in number week by week. When the job has been completed, the machine accounting section is advised and all the cost cards for that job are removed from the file.

These cards are then sorted into class of operation and departmental order and are tabulated. On the printed document will appear the cost of all the individual tasks completed in each department and the total costs incurred in each department. From these data the final cost statement can be compiled after all necessary additional charges have been added. Then the invoice for the customer is prepared. Where quotations have been made, these can be compared with actual costs and the profit margins assessed accordingly.

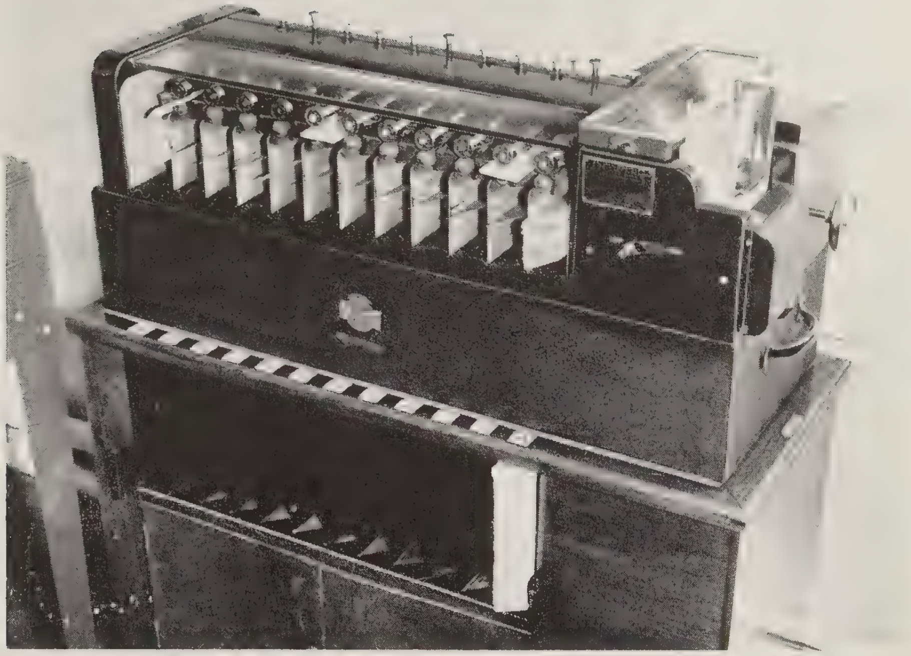
Data derived during this sequence can, of course, be put to many other uses. Each week the total labour and material costs obtained from the weekly tabulations are entered in a ledger and as jobs are completed the associated costs are deleted from the ledger. Consequently, each week, management has accurate figures of the value of all work in progress.

The materials card, of course, provides the basic data for another data processing sequence—stock control. For this a second set of cards is produced by a reproducing punch, which automatically reads data from one card and punches them into a second card at the rate of 120 a minute.

Material cards used in the job costing sequence only refer to materials issued from store. Similar cards are punched for materials received into store. Data of receipts are obtained from the invoices sent in by the suppliers. All these cards are held on file and once every six months a stock statement is prepared.

Each type of material has a stock number and the first task is to sort the cards into stock number order. When tabulated, a list of all receipts and issues of material is printed together

A reproducing punch produces duplicate copies of materials cards for stock control calculations at the rate of 120 *a minute*



Punched cards are arranged in the desired numerical order by this automatic sorting machine

with the balance remaining in store. Calculated balances are compared with actual balances for stock control purposes. In addition the cash value of all stock held is obtained. This provides a useful control figure for management.

A modified procedure for preparing material issue cards is being considered. It is proposed that a large number of materials cards should be pre-punched with standard quantities of material and costs. For example, cards would be prepared giving the cost of 1,000 sheets, 500 sheets, 100 sheets, and so on, for a particular size and quality of paper. These cards would be held on file. When, say, 521 sheets of this paper are issued for a particular job, instead of the cost having to be worked out manually and then punched into a card, three cards would be selected from the file of pre-punched cards. These cards would give the number and value of 500 sheets of paper, 20 sheets and one sheet. By punching the appropriate job number into these three cards the total cost of the paper issued will be obtained by adding together the values on the three cards.

Once a master card has been punched for each item stocked, any number of cards can easily and automatically be reproduced for the pre-punched file. By adoption of this technique, the number of cards handled will increase, but the amount of key-punching and clerical work performed will be reduced considerably. Accuracy is assured because cards are reproduced and totalled by machine, eliminating manual pricing and transcription.

The data processing sequences described in this review demonstrate that a considerable range of work can be performed on a relatively small and simple installation. By using this equipment, The Chapel River Press has been able to produce statistics more readily than was possible previously with manual clerical procedures. As a result, more comprehensive annual statistics are obtained and management can make more accurate forecasts. Positive control has been established over many factors which were only loosely controlled before. And once the equipment was installed, it was found to be suitable for more jobs than were originally envisaged. As stated, the equipment is now loaded to capacity and has been so for five years. Not unnaturally, having proved the worth of punched-card machines, the company is considering obtaining equipment of larger capacity so that more work can be tackled and more complex and comprehensive data processing procedures performed.

TRANSISTORS

A layman's guide to what they are and what they mean to the computer user

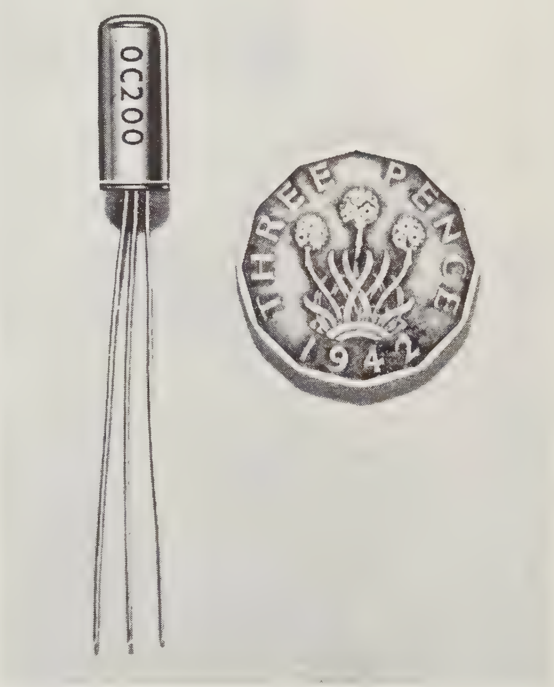
In the second generation of electronic digital computers—now being designed and built—transistors will displace valves. The transistor is more than just a smaller substitute. It possesses characteristics which are being exploited by designers to make better and faster computers and also to extend the number of industrial uses to which the digital computer can be put. Transistor computers possess many features of great interest and importance. To illustrate these points, at the end of the article is a description of the first transistor computer built by Ferranti

THERMIONIC valves, that is valves of the type used in domestic radio sets, have long reigned supreme in the world of electronics. Indeed, the majority of people outside the industry consider valves to be fundamental to any item of equipment graced with the description "electronic". However, about five years ago it became apparent that the supremacy of the thermionic valve had been, or was about to be, broken by a new device called the transistor, and nowadays it is assumed that equipment, if it is to be regarded as modern, must be transistorized—valves are old-fashioned. Needless to say, this is only a half-truth.

Today the majority of computers installed or on order are valve computers. Although nearly all the computers now being designed will use transistors, valve computers will be built for some years to come and continue to provide good service to the user.

To the casual observer, the most obvious difference between a valve and a transistor is size. Transistors are extremely small. A thimble can hold as many as nine or ten. Another obvious difference is physical appearance. Transistors are mechanically solid devices in contrast with valves—each a delicately fashioned assembly of metal parts enclosed in an evacuated glass bulb. Transistors also possess different electrical properties, although they are able to perform similar functions.

A computer built with transistors presents the designer with many new problems. It also possesses many new features, some of great interest and importance to the potential user. From a performance point of view, a transistor computer can perform calculations faster; it is also more reliable in operation. Faults do not occur in transistors as often as they do in valves, and the life of a transistor is longer. This merely emphasizes the greater robustness and simplicity of solid mechanical devices in contrast with assemblies. As a consequence, the time required for routine daily maintenance is reduced and the need for this work will possibly be eliminated. A transistor computer is much easier to install.



Transistors are small solid devices. This is a Mullard silicon alloy junction transistor

It is smaller and weighs less than a valve computer of similar capabilities. Also, no special cooling or air conditioning facilities are needed. Unlike valves, with their heater elements, transistors dissipate little energy in the form of heat. Consequently power requirements are lower. In fact, power requirements are so low that a transistor computer operates from the normal mains power supplies; some of the smaller machines can even work off car batteries.

All this means that, whereas a special room, sometimes with a strengthened floor and other out-of-the-ordinary facilities, had to be provided for a valve computer, a comparable transistor machine can be accommodated in a conventional office and plugged in directly to the standard mains socket.

Grouped round a computer are many auxiliary units, such as punched-card and paper-tape punches and readers, magnetic tape decks and high-speed line printers. Existing units of these types can, of course, be used with transistor machines. Eventually, the transistor will also replace the valve in their construction. However, as the majority of these units are fitted with electric motors, the savings in electrical power will not be so great. Indeed, in the comprehensive data processing installations of the future, more power will be needed to drive the auxiliary equipment than the computer.

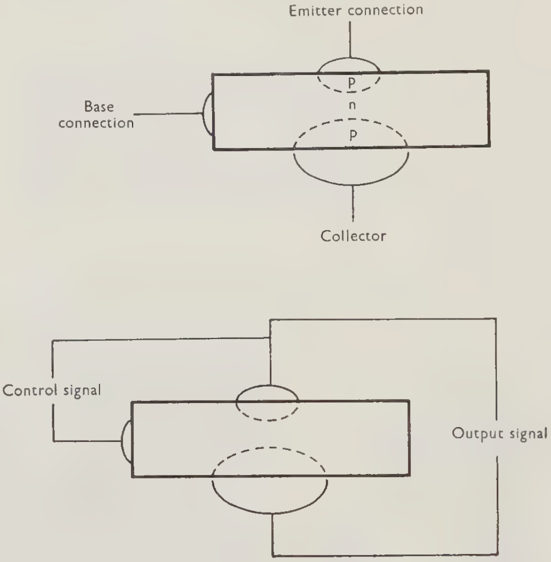
Development of the transistor

Undoubtedly the transistor is the most significant development in electronics since the introduction of the thermionic valve. Transistors were invented in 1948 by a group of scientists working on semi-conductor research in the Bell Telephone Laboratories in the United States. Since then, development has been rapid, until today, only 11 years afterwards, transistors are used in such diverse applications as domestic radio sets, hearing aids, industrial equipment and earth satellites. Over 800 different types of transistor are manufactured, and it is estimated that current world production exceeds 100 million a year.

Transistors are made from semi-conducting materials. These are materials that possess either an excess of electrons or a deficiency and this endows them with the ability, in given circumstances, to conduct an electric current. Germanium and silicon are the two semi-conductor materials most widely used in the construction of transistors.

The original type of transistor was known as a point-contact transistor. This has some unique properties, but, because of difficulties of manufacture, another variety, the junction transistor, came into favour. This is the type now in general use.

Construction of a typical junction transistor is shown below. The *base* is made from a thin section cut from a germanium crystal and the two connections, placed opposite each other, the *emitter* and the *collector*, are made with indium.



(Above) Construction of a p-n-p junction transistor. (Below) A transistor circuit

The germanium crystal used in transistors is not pure—pure germanium is an electrical insulator—small traces of other elements are added to give the crystal the required electrical properties. Additions of arsenic, antimony or phosphorous result in the crystal possessing free electrons; additions of indium, gallium or boron have the opposite effect and cause the crystal to have an electron deficiency. It is these impurities which make it possible for the crystal to conduct an electric current.

Crystals of the former type (surplus electrons) are known as n-type (n for negative charge) and of the latter type (deficient in electrons) as p-type (p for positive charge). The accompanying illustration shows a transistor with a base incorporating n-type material and with indium

Base (magnified) of a high-frequency power transistor developed for digital computer applications

connections alloyed to it, by a heat treatment process; the resultant alloy makes the crystal in the region of each connection, p-type. Hence we have a crystal of which the main part is n-type and which, around the connections, is p-type.

Transistors of this type are described as p-n-p. Conversely n-p-n type transistors can be manufactured by using another material for the emitter and collector connections. Both types function in a similar manner, the major difference being that to make them operate the polarities of the applied voltages are reversed.

The properties of a transistor, including its ability to amplify a signal, are entirely due to the electrical effects that arise at the p-n junctions—hence the term "junction transistor". The most important electrical characteristic is that a current can be made to flow over a junction in one direction—the "forward direction"—but not the other.

Transistor circuit

A junction transistor is connected up to form part of two electric circuits. A voltage—the control signal—is applied between the emitter and the base to assist a current to flow in the "forward direction" over the local p-n boundary. A second voltage is applied between the collector and the base to assist this current to flow over the second p-n junction and so out of the transistor via the collector. This second voltage also prevents any current leaking back from the external circuit through the collector to oppose the original current flow. From this brief description it will be appreciated that the amount of current flowing through a transistor from emitter to collector is controlled by the strength of the signal voltage applied between the emitter and the base. Consequently as the strength of this signal voltage is varied, the current flowing in the output circuit will vary in sympathy. Amplification is achieved because the power of the signal in the output circuit is greater than that in the control circuit.

The passage of a current through a thermionic valve is controlled in a somewhat similar way and, of course, this is the reason why transistors can be used for the same work. A loose comparison can be made between a transistor and a valve: the emitter represents the cathode, the germanium or silicon base the grid and the collector the anode.

Transmission of signal

Paradoxically, although a transistor is physically much smaller than a valve it takes longer for an electric signal to pass through the solid crystal than through the vacuum of a valve. This statement may appear to contradict a previous one which said that transistor computers were faster. The simple explanation is that transistor circuits are much smaller in size than valve circuits: consequently signals do not take so long to travel round them. Overall therefore the transistor machine is faster because it is a smaller machine. High-speed computers are necessarily small computers.

Research, however, has already shown one way in which the transmission of signals through a transistor can be speeded up. This is by grading the dispersion of the impurities through the crystal. As a result, there is an inbuilt electric field which accelerates the flow of current. One of the first computers with transistors of this type will be the Ferranti Atlas, now being designed, which will be able to add two numbers together in 0·0000002 second ($\frac{2}{10}$ microseconds) or multiply them together in 0·000002 second (2 microseconds).

Although at present transistors cost more to manufacture than valves, it is possible that within the next two years, as a result of improved manufacturing techniques, prices will be comparable. Already, however, circuits built with transistors are proving less expensive because the associated equipment is simpler. A case in point is the power supply unit: conventional valve computers require large and costly units because the power requirements are heavy. In contrast, a transistor machine

FERRANTI SIRIUS COMPUTER

The Ferranti Sirius computer is a small general-purpose decimal computer for industrial and scientific calculations. Data may be entered either manually, on a keyboard equipped with 100 keys, or automatically on 5-channel punched paper tape. The machine works directly with decimal numbers, and each decimal digit is represented by a four-bit code. A 1245 code is used.

The main store can accommodate 1,000 computer words (10,000 decimal digits) and additional capacity can be provided by connecting it with units which store 3,000 computer words each. Output data are punched into paper tape at 50 characters a second. Data can be transcribed from paper tape to print at a speed of 10 characters a second.

SIRIUS CHARACTERISTICS

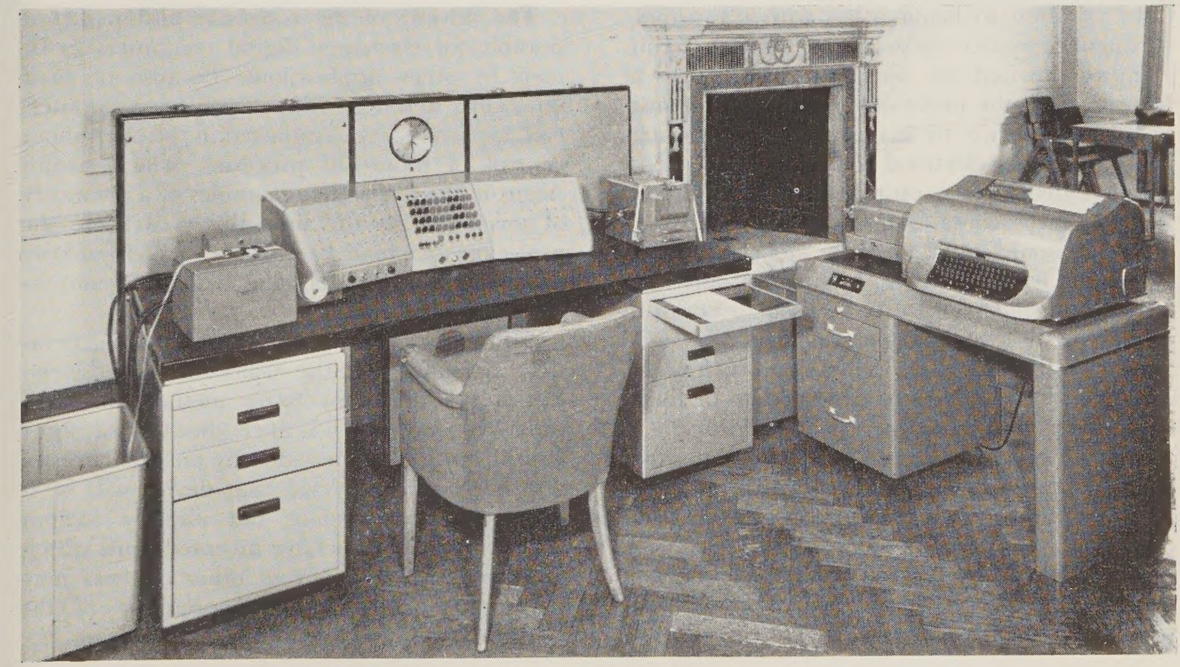
Number system	decimal (binary coded—4 bits per digit)
Mode of operation of arithmetic unit . .	serial
Average times for arithmetical operations	+ 0·24 milliseconds (0·00024 second) × 16 milliseconds (0·016 second)
Type of instruction	single address
Word length	10 decimal digits (40 bits)
Main store	20 nickel delay lines each of 50 words capacity
Data input	punched tape at 300 characters a second
Data output	punched tape at 50 characters a second

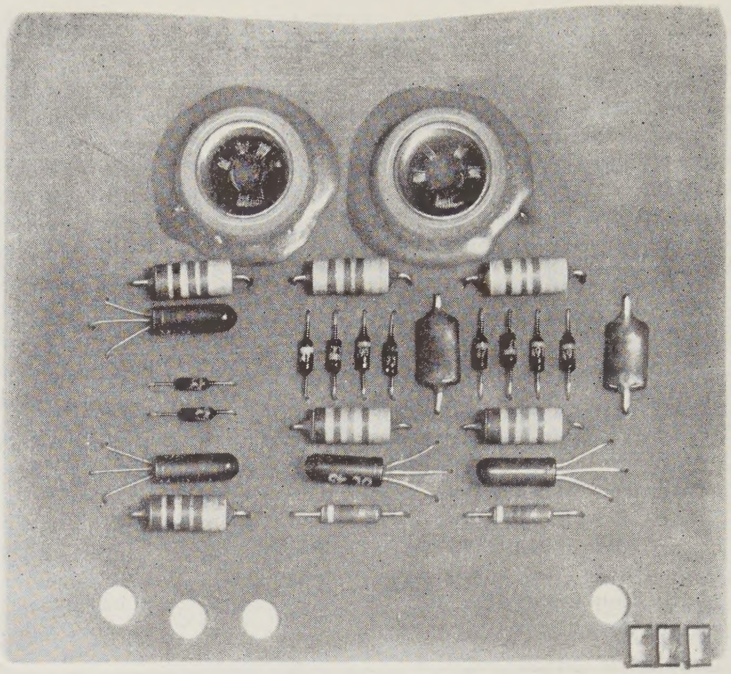
takes only about one hundredth of the power; hence the supply unit is smaller, simpler and less expensive.

Transistor computers can already be ordered from many of the established computer manufacturers and recently Ferranti Limited not only announced Sirius, their first completely transistorized machine, but demonstrated it in action.

Sirius illustrates the advantages of employing transistors, of which 2,000 are used. The computer is small—housed in a cabinet 7 feet long, 4 feet high and 10 inches deep. It is light

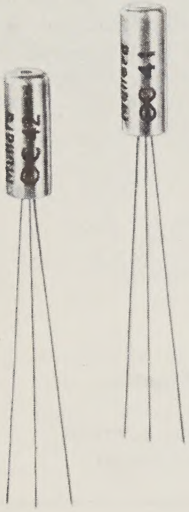
Over 2,000 *transistors are used in the Ferranti Sirius computer. It can operate from a standard electric power point*





(Right) A pair of Neuron circuits mounted on a plug-in board

(Below) Two germanium alloy junction transistors



—560 lb. The control panel, paper-tape reader and paper-tape punch are placed on a standard steel office desk in front of the computer cabinet. No special facilities for cooling the machine are needed, and it can be plugged into a normal 5-ampère power point. It costs £17,500 or may be hired for £15 an hour.

In addition to being fitted with transistors, this new computer makes use of a novel circuit element, devised by Ferranti and called a Neuron after the nerve cell of animal systems; it consists of two transistors, one transformer and a few other electrical components. Neurons are mounted in pairs on plug-in printed-circuit boards. Sirius contains 600 of these boards.

An unusual feature of these Neuron circuits is that, as each has many inputs and only one output, the same unit can be used to perform any of the three logical operations "and", "or", "not". And a computer relies upon such combinations of circuit elements in order to perform calculations and make logical "decisions".*

Because all these circuits can be constructed from a single type of element instead of three or more different ones, Neurons can be produced in larger quantities and therefore at reduced cost. Added to this the cost of dormant equipment, which, in the past, has precluded the adoption of standardized elements, is in this case negligible, because the many input connections of a Neuron comprise only small windings on a transformer.

The advent of the transistor also makes it possible for electronic digital computers to be used in other applications. Because of their reliability and long life, transistor computers can, for instance, be employed in the continuous control of industrial processes. The Ferranti Argus is one of the first examples of a computer of this type. At the time this is written, the prototype machine has been run continuously without a failure for 24 hours a day for 3 months (over 2,000 hours).

All those computers known as second generation machines will use transistors extensively. But if the quest for faster methods of computation continues, it is likely that the transistor will, in turn, be superseded by an even smaller and faster device. What that device will be is still open to question, but already various research laboratories have invented units which show promise, and one or other of these may eventually challenge the supremacy of the transistor, at least in computer engineering.

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*A description of the significance of logical elements and their use in a computer appeared in the article "How an electronic digital computer calculates", *Data Processing* page 21, January-March, 1959.